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State of North Carolina  
Department of Water Resources

FLOOD DAMAGE PREVENTION  
IN NORTH CAROLINA

A Report Prepared for the  
Department of Water Resources  
by Milton S. Heath, Jr.  
Assistant Director, Institute of Government  
University of North Carolina

January 1963

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STATE OF NORTH CAROLINA  
DEPARTMENT OF WATER RESOURCES

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OFFICE OF THE DIRECTOR

December 20, 1962

The Honorable Terry Sanford  
Governor of North Carolina  
Raleigh, North Carolina

Dear Governor Sanford:

I am pleased to submit "Flood Damage Prevention in North Carolina," a report on studies conducted by the Department of Water Resources.

For some years there has been growing concern among the responsible officials in North Carolina with regard to the increasing flood damage potential resulting from developments encroaching upon flood-prone areas throughout the State. This Department, with assistance of other State agencies and the Tennessee Valley Authority, has been encouraging and assisting individual communities to make effective use of flood plain regulations in solving their flood problems.

Yet the dangers increase, as developments continue to push into the flood plains. As a consequence, the Department, with financial and other assistance of TVA, conducted research into the problem and possible solutions and published this report.

This report will be distributed to members of the General Assembly, to officials of local political subdivisions, to other State agencies, and to interested individuals. It is our hope that it will lead to appropriate action, at the State and local levels, which will reduce the danger from floods to life and property in North Carolina.

Respectfully submitted,

*Harry E. Brown*  
Harry E. Brown

16448B ✓



## INTRODUCTION

North Carolina experienced a bitter dose of the ravages of floods during the first half of 1962.

The Ash Wednesday gale in Dare County--\$12 million estimated damage by wind and waves.

Mid-June floods on Town Fork and Little Yadkin watersheds in Stokes and Forsyth County--over \$1 million estimated crop losses.

July 1 dam brake in Granville County--Oxford deprived of its source of city water supply.

Early July rainstorms in southeastern North Carolina--one death and an estimated \$12 million in crop losses and other flood damage.

Thus, in a short four months' time, floods cost one life and over \$25 million in property damage.

Part of the toll of floods is no doubt unavoidable. Another part may be preventable only by physical means, such as flood control dams. There is another approach to abating flood damages, though, which is supported by a growing body of experience: the preventive approach, emphasizing human adjustment to floods rather than control of floods. Many experts believe that this offers the best hope of halting the nationwide trend of increasing flood damage.

This report of the Department of Water Resources describes the nature and scope of the flood problem in North Carolina, reviews experience in North Carolina and elsewhere with various flood damage abatement measures, and seeks thereby to lay a foundation for a broadened state program of flood damage prevention. The report was prepared by the Institute of Government for the Department of Water Resources with financial assistance from the Tennessee Valley Authority. Two graduate students at the University of North Carolina Department of City and Regional Planning, Vernon George and B. S. Eldridge III, assisted in the underlying research and in some of the writing. The report would not have been possible without the splendid

cooperation given by many local, state, and Federal officials. (To say this is no mere routine acknowledgment but should be taken quite literally.) Special thanks and recognition are due to Henry C. Wolfe of the Department of Water Resources and James E. Goddard of the Tennessee Valley Authority for their patient and cogent assistance and counsel. It was a privilege for the Institute to help the Department in the preparation of this, the Department's foundation report on the subject of flood damage prevention in North Carolina.

Milton S. Heath, Jr.  
Assistant Director  
Institute of Government

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Possible Actions to Reduce Flood Damage Potential (chart): Robert W. Kates

Hurricane Donna Damage: Corps of Engineers, Wilmington

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## PART I

### GENERAL SURVEY OF THE FLOOD DAMAGE PROBLEM AND EXISTING FLOOD DAMAGE ABATEMENT PROGRAMS

#### CHAPTER 1

#### SCOPE OF THE FLOOD DAMAGE PROBLEM IN NORTH CAROLINA

##### General

Floods are natural phenomena which occur when the banks of a stream or body of water are filled beyond their capacity, causing water to overflow upon bordering lands. Reasons for the rising of flood waters vary from snow melt to hurricane; but in North Carolina the most significant cause of stream overflow is unusually heavy rainfall of short duration and the most common cause of coastal flooding is ocean storms.

The irregular occurrence of floods tends to obscure the fact that as long as streams have existed, they have occasionally inundated the lands which border them. And hurricanes and other coastal storms have occasionally piled the ocean water over the coastal areas. What may well have been the largest flood experienced in the United States was viewed by remnants of Hernando deSoto's exploration party when the Mississippi River overflowed in 1543.<sup>1</sup> In North Carolina one of the most serious floodings on record occurred in August 1940 when heavy rainfall during the middle and latter parts of the month caused at least 122 overflows. As a result 32 flooded areas in all parts of the State reported heavy damages to crops and property.<sup>2</sup>

Every river subject to flooding possesses a flood plain as an integral feature of its makeup such that when the river is "out of its banks" the land known as the flood plain is subject to inundation. The flood plains along the seacoast and sounds are also integral parts of the oceans and as such are subject to inundation. Of course the width of the flood plain varies with the topography.

"Inherent in the establishment of any area as unsafe because of possible flooding is the implication that the areas which are not thus delineated are secure from possible damage from floods. The degree to which the danger of this implication exists depends upon the criteria used in establishing the limits of flooding."<sup>3</sup>

Settlement of flood plains gives testimony to the fact that damaging floods are too often forgotten soon after they occur. Certainly flood plains are attractive for settlement. Except for brief periods of inundation, the flat and fertile lands which border streams and the attractive beaches along the oceans lend themselves to profitable cultivation and rapid development. But unfortunately, man cannot simply move his crop lands and buildings to higher ground when flooding is imminent. Rather, when waters invade the flood plain, developments are subjected to damage and possibly to destruction. Flood damage is not the natural result of floods but comes as a result of developments in the flood plain.

### Flood Damage

#### Records

On a national basis, the steadiest source of flood damage information is the United States Weather Bureau, Department of Commerce, which has collected national flood loss information continuously since 1902.

In addition, other governmental agencies make damage surveys in connection with major flood investigations and authorized project studies. These agencies include the Tennessee Valley Authority, the United States Army Corps of Engineers, the United States Geological Survey, the United States Soil Conservation Service, the American Red Cross, and a great list of Federal, state, and local agencies whose interests cover varying, but often limited, aspects of the total flood damage picture. (For further details concerning flood damage records for North Carolina, see pages 26-29.)

#### Trends

Numerous observers have noted a trend toward increasing flood damages on a national basis. The role played by continued encroachment on flood plains has been documented by Gilbert F. White and his associates at the University of Chicago in their comprehensive studies (see footnote 4).

Flood damages in North Carolina have also apparently been on the increase. A comparison of selected flood damages during the years 1916-1936 and 1937-1957 based on available governmental records will serve to illustrate



the trend. During the years 1916-1936 there were 24 floods reported to have caused property damages greater than \$10,000. Of these, 16 caused damages in excess of \$100,000. In an equal but more recent period, 1937-1957, there were 70 floods reported to have caused property damage of at least \$10,000. Of these floods, 40 caused at least \$50,000 damage; and of that 40, 28 floods caused at least \$100,000 each.<sup>5</sup>

The trend is further illustrated by an analysis of year-by-year flood damage totals based on these records. During the years, 1916-1936 the average annual reported property damage in the State was \$411,922. In the period 1937-1957 the annual damage was \$1,224,147, representing nearly a 200-percent increase.<sup>6</sup> By comparison, initial estimates of damage from major floods alone in North Carolina during the first half of 1962 exceeded \$25 million.

Hoyt and Langbein state:

"Of the increase in property damage by flood, we may ascribe about 45 per cent to the increase in property values, 25 per cent to an increase in the amount of flooding, and 30 per cent to an increase in building and other uses in flood hazard lands."<sup>7</sup>

When we were an agricultural Nation, occasional flooding did not create serious problems and only the largest of floods were significant. But now, partially through misguidance and partially in spite of the flood damage risk, industrial, commercial, and residential developers are pushing farther into the flood plains of North Carolina and the Nation as a whole. In many areas, the developments have been spurred by a misconception of the function of flood control structures. Flood control structures are not ordinarily designed to eliminate all flooding. Rather the dams, dikes, levees, and channel improvements are intended to significantly reduce flooding either with regard to area inundated or peak flow, thereby reducing damages under the development conditions existing at the time of design. When flood plain encroachment reaches the area of inundation of the reduced flood, developments in the regulated flood plain are subject to damage.

The encroachment problem in North Carolina is illustrated by the Cape Fear River Basin. Due to the flood of 1945, damages estimated at \$4,700,000 were suffered all along the Cape Fear River. It is estimated that a flood of like degree, occurring with the state of development in 1960





and in the absence of land use control measures, would cause over \$10.9 million in damage.<sup>8</sup> The Wilmington District of the Corps judges that approximately one-third of this increased damage potential is due to encroachment, one-third to change in dollar value, and one-third to improved methods of obtaining damage estimates.

Another illustration of the encroachment problem in North Carolina will be found in the Crabtree Creek area in Wake County. A 1959 storm there caused estimated urban damages of over \$100,000. Equal flood stages in prior years had not caused such heavy losses, because the flooded areas were then less developed. Another comparison--the 1957 storm affected 50 homes; a recurrence of this storm today would affect an estimated 150 homes. (See page 99.)

#### Flooding

Any list of the major floods experienced during this century in North Carolina would certainly include:

The floods of 1954 following Hurricane Hazel throughout much of the eastern and Piedmont sections, and also the general floods following the 1955 hurricanes.

The great floods of 1916 in western North Carolina, notably along the French Broad and Catawba Rivers.

The extensive 1940 floods, especially along the Roanoke, Yadkin, Pigeon, and French Broad Rivers.

The floods of 1908 and 1945 on the lower Cape Fear, and 1908 on the Chowan River.

The 1919 and 1924 flooding along the Neuse River.

The 1919, 1928, and 1940 floods on the Tar River.

The 1962 floods in large areas of eastern North Carolina resulting from ocean storms and early summer rainstorms.

A number of unusual localized floods in small drainage areas--to name two examples, the heavy flooding in Randolph County in 1960 and in Stokes County in 1962.



It would be extremely helpful for a community with a flood damage hazard to establish a relation between the frequency of floods and flood damages. To determine such a relationship would require an extensive analysis of flood damage history for that area, and the preparation of a frequency relation from which flood stages could be predicted. Unfortunately, both of these procedures are questionable in the opinion of many observers.

As to the former, comparison of national flood loss statistics from flood to flood and locality to locality is questionable for three primary reasons:

"(1) The determination of value of physical goods and property often fails to take into account obsolescence, deterioration, and future income producing capacity in calculating the present worth of the property.

(2) Depreciation in property value is used indiscriminately as a measure of loss to the property. The addition of damage to depreciation gives a value far in excess of the actual loss.

(3) Valuation of losses resulting from interruption in the production of goods and services is especially controversial."<sup>9</sup>

While the comparison of local flood loss statistics from year to year would not be subject to the compounding of error that a national comparison would produce, the accuracy with which local trends could be discerned would be questionable. An examination of North Carolina flood loss statistics shows that even an analysis of flood damages in one locality would fail the needs of any precise study such as a damage-frequency relation.

In the second place flood frequency determinations, although a product of rather refined statistical methods, have not yet won the continuing respect of those who would benefit most from their use. The reliability of any statistical analysis depends upon the reliability of the sample of data from which the analysis is made. Due to the irregular appearances of floods and their relative infrequency, a reliable sample of flood data must necessarily cover many years.

The most extensive analysis of flood frequency which has been prepared for streams in North Carolina is a United States Geological Survey report, Floods in North Carolina, Magnitude and Frequency, originally published

in 1955 and revised in 1961. This report shows that the longest continuous stream gage record in North Carolina has been kept for 73 years at Fayetteville on the Cape Fear River where gaging has been in operation since 1889.<sup>10</sup> While the stream gage record at Fayetteville may provide information for a fairly reliable frequency analysis at that point, this may not hold true for the shorter records for the other gaging stations in the State. The 1955 report states:

"... the small sample of annual floods may not truly represent the long term frequency relation because of random variation and possibly because of time trends."<sup>11</sup>

Finally, there is some concern that the use of such terms as "recurrence interval" will be misleading. It is feared that such terms suggest that a given flood may be expected to occur at regular intervals, and this is not the meaning intended. A flood which has been determined from the North Carolina frequency study to have a recurrence interval of, for example, 50 years may occur in any given year or in successive years. To say that the flood has a recurrence interval of 50 years is to say that the chances of that flood's being the largest flood to occur in any given 365-day period are 1 in 50.

#### Flood Prone Areas of North Carolina

Where do damaging floods occur in North Carolina? The answer is: almost everywhere. As might be expected the most susceptible areas are (1) the exposed coastline, (2) cities and towns traversed by major streams, and (3) bottomland farms lying within the flood plains of streams.

A picture of these susceptible locations can be obtained from the map on page 10. This map portrays flood prone areas, as reflected by reported flood damage. As appears from the map, one or more communities in most of North Carolina's counties have experienced sufficient flood damage to be reflected in some official report by SCS, TVA, the Geological Survey, the Corps of Engineers, the Weather Bureau, or another government agency. In addition, at least eleven counties have suffered general flood damage of county-wide proportions.

### Dam Failures

A special set of problems is posed by the risk of dam failures. Foremost, of course, is the threat of a "Johnstown flood"--a sudden failure of a large dam causing catastrophic loss of life and property damage. In the Johnstown, Pennsylvania, flood a dam built to store water for the Pennsylvania Canal ruptured in 1889. The wall of water that was released virtually wiped out a city and several towns in its path, killing over 2,000 persons and causing an estimated \$12 million in property losses.

Shading down from this are lesser but still significant risks, such as the possible loss of a source of public water supply in the case of a city reservoir impoundment. Altogether, the potential dangers are quite unique, as are the avenues for abating these dangers. Because of this, a number of states license and inspect dams in the interest of public safety. (See pages 65 and 66.)

Fortunately North Carolina has never experienced a disaster of the magnitude of the Johnstown flood. But dams have failed in North Carolina, resulting in substantial property damage. The most memorable instance, perhaps, was the breaking of a dam approximately 450 feet long and 60 feet high at Lake Toxaway in Transylvania County in August 1916. As far as 20 miles downstream the resulting high water washed out a bridge located 25 feet above normal stream flow. There was no reported loss of life. Property damage included destruction of the dam and powerhouse (built at a cost of \$60,000) and some downstream damage to homes and crops.<sup>12</sup>

The last several years, according to reports from the State Highway Commission, have seen dam failures which caused highway damage ranging from a few hundred dollars to \$60,000, in Randolph, Johnston, Hertford, and Mitchell Counties. In at least one of these cases there was also substantial damage to nonhighway property.<sup>13</sup>

Known instances of failures of municipal water supply dams include the Greensboro city reservoir dam some dozen years ago, and the Oxford dam of recent memory (July 1962).



OXFORD CITY RESERVOIR DAM FAILURE , 1962



**LEGEND**

★ CITIES AND COMMUNITIES FOR WHICH SOME DAMAGE HAS BEEN REPORTED.

▲ COUNTIES FOR WHICH GENERAL DAMAGE HAS BEEN REPORTED.

Note: In the course of this project a list was made of every location for which flood damage was reported in published or unpublished records of the various federal agencies. This map

Note: In the course of this project a list was made of every location for which flood damage was reported in published or unpublished records of the various Federal agencies. This map shows all of the locations contained on that list. It makes no distinctions based on the amount of damage. It probably reflects most of the places in the state that have suffered flood damage, but may not reflect them all, since the records on which it is based do not claim to be comprehensive. Coverage is through July 1, 1962.



## CHAPTER 2

### METHODS OF ABATING FLOOD DAMAGE

This chapter is designed to furnish an introduction to the various methods that have been and are being used to alleviate damage from floods. Later chapters will cover in detail the matter of who is responsible for carrying out the various flood damage abatement programs. Here we deal only with the question of how to prevent or reduce the toll of damage.

#### Corrective Measures

The most familiar and best established method of combating floods is through physical protective measures--dams, dikes, channel improvements, and the like.

In one sense the choice of physical methods of flood protection is rather simple: Either build a wall that will serve as a dam or dike to temporarily retard the flood runoff, or improve a channel in order to more efficiently and rapidly carry floodwaters away from damage-prone areas.

In another sense the possibilities for physical control may be quite complex. Consider the dam as a means of flood protection: It may be one of several types of construction (earth, concrete, etc.). It may be located on a small upstream tributary or on the main stream of a river. It may be a single independent unit or a part of a system of dams. It may be single purpose in nature (designed solely or principally for flood control) or multipurpose. Its object of protection may be primarily urban property or rural property or industrial property, and so forth. And finally, the dam may be the exclusive form of protection or it may be installed in conjunction with dikes, channel improvements, and other measures aimed at preventing flood damage.

Similar distinctions could of course be made with respect to the other main forms of physical protection--the dikes and the channel improvements.

### Preventive Measures

Of more recent application are a number of preventive measures to reduce flood damage by human adjustment to floods rather than through physical protection. Their aim is "to keep man away from water" in contrast to the object of the protective approach, "to keep water away from man." Foremost among these measures are regulations controlling the use of land in places susceptible to flooding, whose purpose is to guide and control the development of these areas into uses that will limit potential flood damage. Some of the earliest and best publicized of these efforts took the form of zoning ordinances applicable to flood plain areas. As a result the name "flood plain zoning" became associated with these measures. A far broader range of land use regulations is potentially involved, however, including channel encroachment laws, subdivision control ordinances and building codes.

A variety of other forms of human adjustment to flood situations can be catalogued. To describe them briefly we can do no better than quote the following discussion found in a recent publication of the Task Force on Flood Plain Regulations of the American Society of Civil Engineers:<sup>1</sup>

#### "Other Measures

In addition to flood plain regulations, the measures discussed briefly in the following paragraphs should also be considered as essential features of any comprehensive flood damage alleviation program.

Flood forecasting - Flood forecasting and warnings for the larger streams can save lives and property located in flood hazard areas. Due to the highly technical nature of the work involved and the interstate factors which must be considered, the Federal Government has provided the leadership in developing and operating the major flood forecasting system.

Temporary evacuation - Temporary evacuation of persons and property from the path of flood waters is another important partner in alleviating flood losses. Once aware of impending high water, homes can be evacuated, material raised above flood waters or removed to higher ground, emergency protective measures can be undertaken and the flood fighting and relief agencies activated.

Permanent evacuation - Permanent evacuation of developed areas subject to inundation involves the acquisition of lands by purchase--through the exercise of the powers of eminent domain if necessary--the removal of improvements and the relocation of the population from such areas. Lands so acquired could be used for agriculture, parks, or other purposes which would not interfere with flood flows or result in material damage from floods.

Open spaces - Today great emphasis is being placed upon the growing need for vastly increased areas for recreational and other open-space uses. Development rights, easements or fee title to presently undeveloped flood-prone areas adjacent to rivers might thus be acquired by Federal, state or local governments to provide these needed areas at reasonable costs. A number of localities throughout the country are using this method to remove the temptation for the development of cheap lands and to put them to a needed useful purpose. Such projects have largely been carried out at the local governmental level sometimes with the assistance of benefactors.

Flood proofing - Flood proofing measures taken to render existing or proposed structures, property, and grounds less vulnerable to flood losses are an important and effective adjunct to flood protection.

Flood insurance - Flood insurance, if established on a sound and equitable basis, could provide still another supplement to many flood damage alleviation programs. In order that insurance of flood losses does not encourage improper development of flood plains, however, rates should realistically reflect the flood risk. Such risk would be reduced by regulation of use of the flood plain. The Congress authorized through its Federal Flood Insurance Act of 1956 a subsidized, experimental insurance program but has not appropriated funds to carry out its provisions.

Urban redevelopment (renewal) - This can be used in flood-blighted areas which are a drain upon the economic life and welfare of the community and which do not lend themselves to other methods of regulation and control. The Federal Urban Renewal Program enacted by Congress in 1929 and considerably amended and enlarged in scope since that time provides substantial assistance to municipalities burdened with such conditions.

Such a redevelopment program should include setting aside the lower flood plain areas for parks, open spaces, and such other uses that are not

subject to substantial flood damages. Public parking areas may be designated, providing adequate regulations or precautions are set up. The upper areas can be utilized for new structures so as to minimize flood damage..

Warning signs - The conspicuous display of signs indicating the specific heights of flood waters and the dates of the events is useful in informing the inexperienced developer and the prospective purchaser of flood conditions in the area. Signs bearing general flood information are likewise effective.

Tax adjustments - Tax adjustments for land dedicated to agriculture, recreation, conservation, or other open-space uses may be effective in preserving existing floodways along streams. Unless such concessions are made, rural farm land adjacent to communities will become more valuable each year as residential or commercial developments move into parts of it, causing the tax evaluation of all adjacent farm land to rise to the point that the land no longer can profitably be used for farming or open uses.

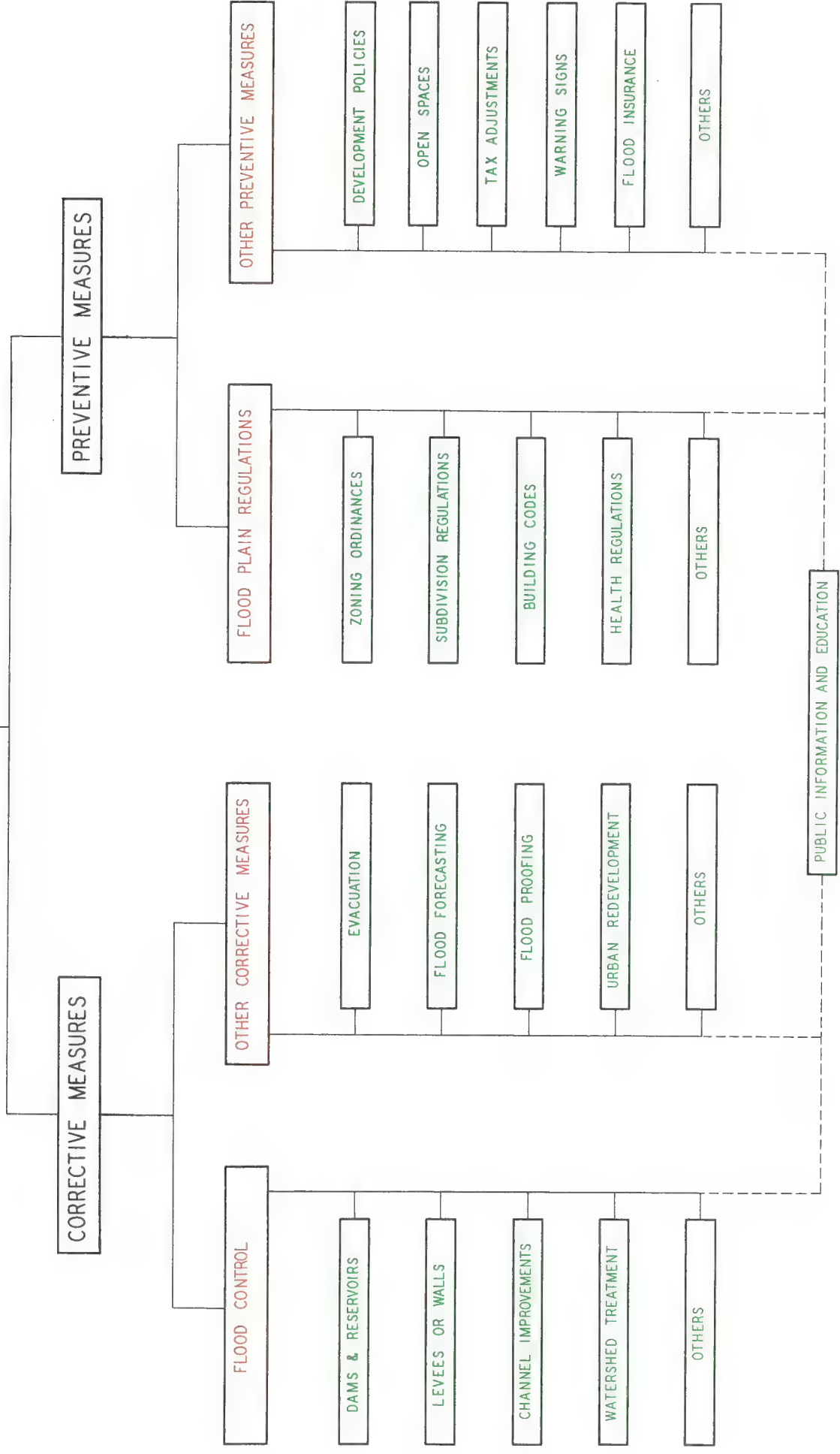
Development policies - Resistance to the extending of utilities and to the construction of local streets will deter development in flood plains, as will many other wise day-to-day policy and action decisions. Street improvements elsewhere, schools and other public facilities all wield a soft-sell negative influence on flood plain exploitation and a positive leadership toward the higher ground."

A chart illustrating the corrective and preventive approaches to flood damage abatement is reproduced on page 15.

Many reasons have been given for the emergence of the preventive approach to flood damage abatement. We note here four that are prominently mentioned.

First, the flood plain is the natural avenue for floods to travel. It is unwise to build residences or commercial buildings directly in the path of floods, or even to calculate the odds too closely. For when major floods arrive they may well claim far more ground than has been anticipated. In recounting the havoc of Hurricane Diane in the Naugatuck Valley of Connecticut, Fortune Magazine sadly remarked:

# FLOOD DAMAGE PREVENTION







. . . They had prepared for the future in terms of the past and when the future arrived on August 18 and 19 it so far exceeded expectations as to render all preparations futile.<sup>2</sup>

Second, as Goddard has observed:

. . . a "corrective" approach to any basic problem can never win a complete victory. For years and years many of those engineers and officials working to provide relief from floods have wondered if the historic flood control measures were enough. They have observed subdivisions and industries locating in flood hazard areas at an increasingly rapid rate in recent years as pressures of urban expansion seem to overcome logic.

. . . The rate of encroachment on the flood plains is so great that despite the gigantic and costly, though efficient, flood control efforts the flood damage potential is increasing.<sup>3</sup>

Third, flood control works, unless vigorously supplemented by preventive measures, are an invitation to further encroachment. The failure to closely coordinate urban land use controls with flood control projects, in the words of Gilbert F. White, results in making the U. S. Army Corps of Engineers "against its inclinations, one of the major real estate development agencies in the country. The effect of its operations on more than 650 urban flood plains is to stimulate and support occupancy changes which already are in progress."<sup>4</sup>

Fourth, another limitation upon flood control works (and argument in favor of greater emphasis upon preventive action) is financial. It is increasingly hard to find sources of funds to support construction of protective works. To quote Goddard again:

Flood control . . . has heavy competition for the tax dollar. With the necessity of maintaining adequate defenses and effectively upholding the free world, the Federal Government finds it necessary to limit the funds for such protective structures. State governments also have more pressing programs, such as highways and education.<sup>5</sup>

## POSSIBLE INDIVIDUAL AND PUBLIC ACTIONS TO REDUCE FLOOD DAMAGE POTENTIAL

| TYPE OF ACTIVITY                                 | INDIVIDUAL ACTIONS                                                                                       | PUBLIC ACTIONS (To Encourage, Reinforce, or Mandate Ind. Actions)                                                                                                                                                                  |                                                                                                                                                         |
|--------------------------------------------------|----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                  |                                                                                                          | STATE-COUNTY-MUNICIPAL                                                                                                                                                                                                             | FEDERAL                                                                                                                                                 |
| NO REMEDIAL<br>ACTION<br>PRACTICABLE             | Bear an expected loss*                                                                                   | Provide flood hazard information*                                                                                                                                                                                                  |                                                                                                                                                         |
|                                                  | Set aside funds for a future loss*                                                                       | Provide relief to ease suffering and distress<br>(In a manner as to reduce future damages)                                                                                                                                         |                                                                                                                                                         |
| TEMPORARY<br>EVACUATION<br>AND FLOOD<br>FIGHTING | Maintain standby preparations<br>for flood-fighting*                                                     | Provide men and materials for emergency flood-fighting**                                                                                                                                                                           |                                                                                                                                                         |
|                                                  | Prepare plans for temporary<br>evacuation of life and property<br>and the rescheduling of<br>production* | Organize community plans for<br>warning and evacuation assistance*<br><br>Provide Federal warning<br>assistance and expanded<br>radar network**<br><br>Encourage local disaster plans<br>to provide for flood damage<br>reduction* |                                                                                                                                                         |
| FLOOD<br>PROOFING                                | Provide structural adjustments<br>available for old and new<br>buildings*                                | Use building codes to make<br>flood proofing mandatory<br>or to keep structures above<br>floods*                                                                                                                                   | Provide hazard information<br>for design of flood proofing*<br><br>Require flood proofing in<br>flood-prone areas for HHFA<br>and other loan assistance |
|                                                  | Use land elevation (fill) to<br>keep new buildings above flood<br>level**                                | Use encroachment laws to<br>prevent damage to others as<br>a result of land elevation*<br><br>Use building code to make<br>land elevation mandatory*                                                                               | Provide hazard information<br>for design of land elevation*<br><br>Require land elevation in<br>flood-prone areas for HHFA<br>and other loan assistance |

|                                |                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                               |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GUIDING<br><br>LAND<br><br>USE | Locate structures so as to minimize damage**<br><br>Guide land to open use such as: parks, playgrounds, parking lots, etc.*<br><br>Abandon high-hazard areas*                                                    | Mandate patterns of land use by flood plain regulations**<br><br>Encourage open uses**<br><br>Prohibit uses subject to high damage or loss of life**<br><br>Use condemnation power and/or urban renewal to change land use                                   | Provide hazard information for design of regulations*<br><br>Require flood plain regulations as a provision for flood control, urban renewal, and similar assistance<br><br>Use HHFA and other Federal loan assistance powers to discourage improper flood plain use*<br><br>Provide aid to permanently evacuate flood plain* |
| CONTROLLING<br><br>FLOODS      | Construct levees or walls, channel improvements, detention reservoirs*<br><br>Request and promote local, state, and Federal flood control projects*<br><br>Share in costs of local, state, and Federal projects* | Construct flood control projects*<br><br>Request and promote state and Federal flood control projects**<br><br>Share in costs of Federal projects*                                                                                                           | Provide flood control in the form of levees, walls, channel improvement, land treatment, detention reservoirs**                                                                                                                                                                                                               |
| FLOOD<br><br>INSURANCE         | Obtain a policy*<br>(Available under one of the following conditions:<br>a) High premium<br>b) Pooled risk with off-flood plain structures<br>c) Structural adjustments reduce more frequent flood damage)       | Provide standardized flood hazard information on which to base rate structure<br><br>State supervision of insurance companies to encourage commercial policies that promote minimization of flood damages<br><br>Subsidize a state-Federal insurance program | Subsidize a Federal or Federal-state insurance program<br>(Administered to promote minimization of damages)                                                                                                                                                                                                                   |

\*\*Present application limited

\*\*Present application widespread





## CHAPTER 3

### EXISTING FLOOD DAMAGE ABATEMENT PROGRAMS OF THE FEDERAL GOVERNMENT IN NORTH CAROLINA

Taken as a whole the United States Government and its agencies in North Carolina constitute, first, the prime mover and principal source of funds for flood control projects involving channel improvements, building of dams and dikes, and other physical measures; second, the best source of general data bearing upon flood damage and flood control; and third, a useful source to which localities with flood damage problems can turn for competent professional studies of their particular problems.

This chapter will review these activities, beginning with the preventive and information programs, and concluding with the corrective flood control measures. The Federal agencies most concerned with flood damage problems include the U. S. Army Corps of Engineers, the U. S. Soil Conservation Service, the Tennessee Valley Authority, the U. S. Geological Survey, and the U. S. Weather Bureau. For convenience, we will usually refer to them by their familiar shorthand designations: "Corps," "SCS," "TVA," "USGS," and "Weather Bureau."

#### Preventive and Information Programs

##### Local Flood Plains Studies

Several Federal agencies have taken the lead in developing programs of intensive studies of localized flood problems, aimed mainly at supplying information needed as a foundation for land use planning and regulation in flood plain areas. TVA pioneered in this preventive approach to flood damage reduction for many years, and its lead has recently been followed by the Corps and the USGS.

TVA Local Flood Relations Program--By virtue of the system of TVA dams and reservoirs, the Tennessee River and its tributaries constitute one of the best controlled river systems known to man. But no set of physical structures can give one hundred percent flood protection; damaging floods can still occur at many points in the Tennessee Valley. A majority of these

points lie on tributaries unprotected by the river control system. Some, though, lie on the main river or on tributaries downstream from regulating structures.

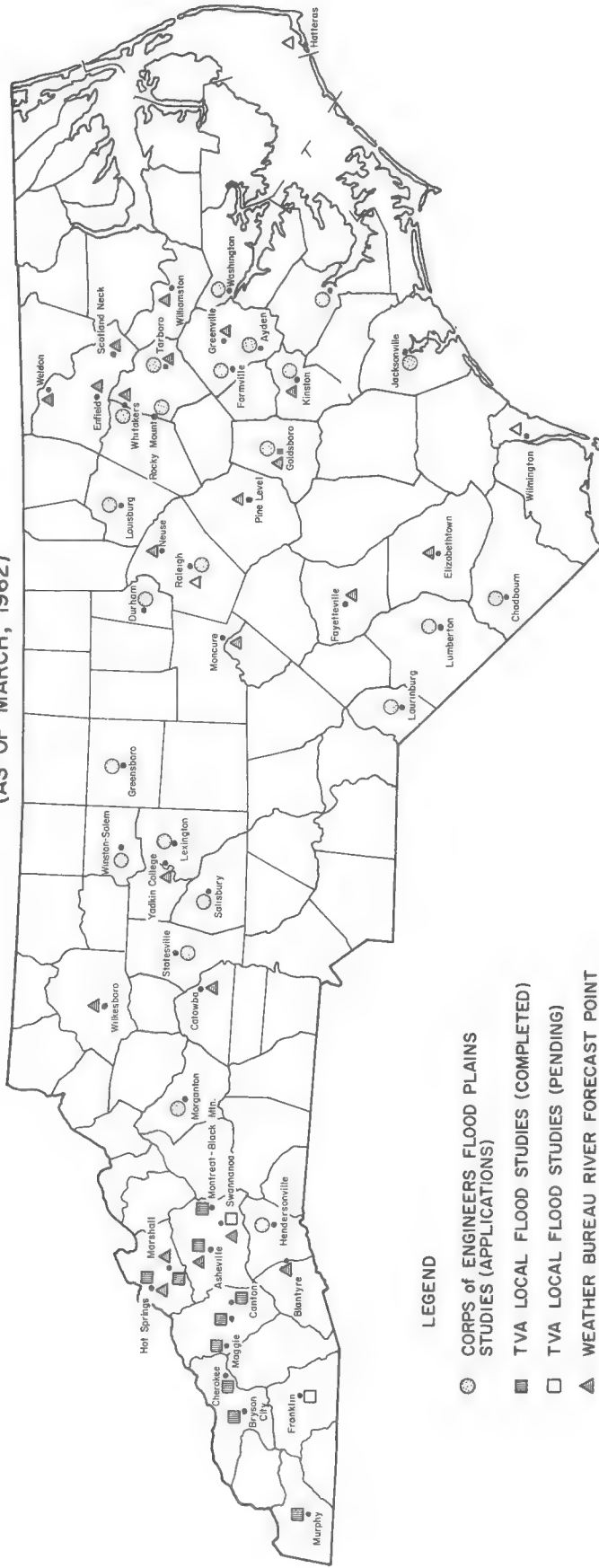
Recognizing that all flood problems cannot be economically solved by water control structures and that preventive measures are a necessary supplement to such structures, TVA in 1953 launched one of the broadest programs of flood damage prevention ever attempted in any river basin. To supplement its flood control system, TVA indicated its readiness to prepare factual reports on flood situations in local areas within the Valley at the request of local or state interests. By July 1962 some 80 reports covering 97 communities had been completed. Twelve of these are in North Carolina: Asheville, Black Mountain, Montreat, Bryson City, Canton, Cherokee, Clyde, Hendersonville, Hot Springs, Maggie, Marshall, and Murphy. Studies for about two additional North Carolina communities annually are proposed, Franklin and Swannanoa in fiscal year 1963. Other localities in North Carolina lying within the Tennessee River Basin which have been identified by TVA as having local flood problems that might merit study include: Cullowhee, Dillsboro, East Laport, Enka, Robbinsville, Spruce Pine, Sylva, Tuckaseegee, and Waynesville.

James E. Goddard, who supervises this TVA program, has summarized TVA's policy as follows:

- "1. Initiative for a study must come from the local community. . . .
2. The local request must be made to the appropriate state officials who then transmit it to the TVA along with a request from the State for such assistance. . . .
3. TVA also makes it clear that facts obtained in the studies will be presented without reservation and that changes will not be made in them to ameliorate local feelings or interests.
4. TVA reports do not include recommendations as to what the community should do to solve its flood problems. The reports are factual. They provide a basis for the state and local people to analyze their need and problems."<sup>1</sup>

The first section of a typical report is a thorough flood history. The flood history will include descriptions of past floods, and a compilation and analysis of available hydrologic data.

# LOCAL FLOOD INFORMATION STUDIES RIVER FORECAST POINTS & RADAR STATIONS (AS OF MARCH, 1962)



## LEGEND

- CORPS of ENGINEERS FLOOD PLAINS STUDIES (APPLICATIONS)
- TVA LOCAL FLOOD STUDIES (COMPLETED)
- TVA LOCAL FLOOD STUDIES (PENDING)
- ▲ WEATHER BUREAU RIVER FORECAST POINT
- △ WEATHER BUREAU RADAR STATION

The second section of the typical report predicts future flooding prospects. In making its predictions TVA has carefully avoided referring to specific flood frequencies, such as "one hundred year flood" or "one hundred fifty year flood." Such precision can rarely be justified from available data, and experience suggests that it may create a popular expectation that floods of stated frequencies occur at regular intervals, which is not the case at all.

TVA's customary approach has been to project two types of floods that are important for planning purposes: a "Regional Flood" and a "Maximum Probable Flood." The "Regional Flood" is derived by considering historical floods in comparable watersheds within the surrounding region, a radius of 50 to 75 miles. The purpose is to identify floods that, except for vagaries of the weather, could just as well have occurred and produced like effects in the community under study. The "Maximum Probable Flood," as the name suggests, is the largest flood that might reasonably be expected to occur in the area, typically larger than any actual historical flood. This concept is most useful as an ultimate safety factor--for example, in designing flood control works whose failure might have disastrous results.

The completed flood report is ready to serve its basic function as the foundation for local planning of land use in the flood plain area. Its applications are many and varied.

In highly developed areas, the report may suggest a need for physical control works.

Throughout the region, it may point up the need for regulation through zoning ordinances, subdivision control ordinances, and building codes, and may serve as the factual basis for these regulations.

It may help to identify areas where public acquisition of land for park purposes or open space use is indicated as an alternative or supplement to land use regulation.

It may serve as a guide for municipal utility expansion policies in flood-prone areas, and aid in developing standards for location and construction of public buildings.

It may help business and industrial establishments to plan new construction or acquisition of new sites.

Twenty-six communities in the Tennessee River Basin have adopted flood plain zoning ordinances or subdivision control regulations or both. More than half of the communities for which reports have been prepared have utilized the flood data in some official manner. The reports have also been used frequently by private citizens, industries, Federal housing agencies, industrial development agencies, state highway departments, and others to guide their planning and operations.

The TVA Board of Directors early in 1959 recommended to the Congress that the objectives of this program be carried forward and implemented as a matter of national policy. In its recommendation the Board stated in part:

"As a prerequisite for the contribution of Federal funds to local flood protective works, State and local governments should be required to adopt and administer flood plain zoning and other such controls as are needed to prevent the unnecessary spread of buildings and other improvements in areas subject to flood damage.

Provision should be made to insure that all Federal agencies having responsibility related to site selection or financing of physical structures observe local flood plain zoning and other standards in carrying out their responsibilities. . . ."<sup>2</sup>

Even more recently TVA's Goddard has spearheaded a move to arouse interest within the civil engineering profession in the preventive approach to reducing flood damages. This has resulted in publication by the American Society of Civil Engineers early in 1962 of "A Guide for the Development of Flood Plain Regulations."<sup>3</sup> This pamphlet is an excellent introduction and guide to the subject, and should be studied by any community that is interested in adopting flood plain regulations.

#### U. S. Army Corps of Engineers Flood Plain Information Studies--

Perhaps the most telling impact of the TVA flood plain report is reflected in action recently taken by the Corps of Engineers. The Corps obtained authorization from Congress in 1960 to initiate a comparable program of local flood plain studies. (The authority was conferred by section 206 of the Flood Control Act of 1960, hence the name "206 Studies.") Five hundred thousand dollars was granted by Congress to launch these studies in fiscal year 1962.<sup>4</sup> The Corps has issued a manual outlining the approach to be followed and the initial studies are already under way.<sup>5</sup> Under the guidelines adopted, studies



may be either full scale information studies or compilations of miscellaneous readily available data.

In North Carolina the Department of Water Resources publicized the availability of the new Corps program in spring 1961 with help from the North Carolina League of Municipalities and the Institute of Government. By late June a dozen cities and towns had placed requests for studies: Ayden, Farmville, Goldsboro, Greensboro, Jacksonville, Kinston, Louisburg, Lumberton, New Bern, Raleigh (Walnut Creek Valley area), Rocky Mount, and Tarboro. By March 1962 another eleven requests had been received by the Corps from: Chadbourne, Durham, Hendersonville, Laurinburg, Lexington, Morganton, Salisbury, Statesville, Washington, Whitakers, and Winston-Salem. At this writing studies have been approved by the Corps for Raleigh, Farmville, Lexington, and Winston-Salem, and the Raleigh study has been started. Formal applications for studies have been approved by the State Department of Water Resources and forwarded to the Wilmington District Engineer for Durham, Farmville, Goldsboro, Greensboro, Louisburg, and Tarboro, and additional requests are being processed.

The Corps requires local applications in North Carolina to be placed through the Department of Water Resources, so as to take advantage of state coordination and supervision. The locality will be asked to fill out a standard request form stating the desired scope and objectives of the study, and giving a cost estimate. Studies will be scheduled by the Corps. If the volume of requests demands it, some kind of priority system may be established, which may result in lengthy delays for some applications because of their comparative insignificance. Projects will be undertaken by the Corps only for a responsible local governmental agency or coordinating body which can assure that the studies will be publicized locally and made available for use or inspection by all interested parties. The Engineer District concerned will give public notice when reports are completed and will furnish copies to state and local officials, to other Federal agencies and to members of Congress.

U. S. Geological Survey Flood Hazard Maps--A third possible source of help for communities seeking guidance in identifying flood-prone locations for local planning purposes is the United States Geological Survey, a branch of the Department of Interior. The USGS will prepare flood-hazard maps on a 50-50 cost sharing basis showing the areas inundated and elevations for selected historical floods. While useful guides, these maps do not supply

the complete information to be found in a TVA or Corps flood plains study. In addition the community must share in the cost, which is not required by TVA or the Corps. The flood hazard map can often be produced more quickly, though, and this may be an important consideration in some localities.

To date, the Raleigh office of the USGS reports no flood hazard map has been requested or prepared for any community in North Carolina.

#### Other Data Collection, Research, and Related Activities

In addition to the local flood studies programs just reviewed there are several other continuing programs of data collection, research, and related activities that should be mentioned. TVA, SCS, the Corps, and the USGS all conduct such programs. The U. S. Weather Bureau and the U. S. Forest Service are also useful sources of information pertinent to flooding problems.

U. S. Weather Bureau--The Weather Bureau has collected and published information on stream stages, floods, and flood damages since 1902. Among its publications that have some bearing on flood problems are the following (by current titles):

Daily River Stages--An annual publication showing daily river stages at gaging stations on major rivers throughout the country (there are about 20 locations reported for North Carolina).

Climatological Data, National Summary--A monthly publication (with an annual summary issue) containing a review of river and flood conditions, special storm reports, and flood stage data, as well as a variety of climatological data.

The Daily Weather Map; The Weekly Weather and Crop Bulletin; and The Monthly Weather Review--Periodical reviews of weather conditions throughout the Nation.

Research Papers and Technological Papers--Individual papers containing reports of original research on specific meteorological problems and compilation of meteorological and climatological data. Subjects

covered include daily river stage data on important floods, and precipitation forecasting for the Tennessee Valley.

The archives and distribution center for the Bureau's various publications is located at Asheville: "The National Weather Records Center."

The raw data concerning floods that goes into these publications is collected and filed at local Weather Bureau offices. Three such offices serve most of North Carolina. One, located at Raleigh-Durham Airport, covers all of the rivers emptying into the Atlantic Ocean from North Carolina. Another, at Asheville, covers the French Broad River and its tributaries. The third, at Charleston, S. C., covers the Waccamaw, Black, Peedee, and Edisto Rivers and their tributaries. Collection of these flood loss data begins at the local level when questionnaires are sent to county agents, county and city engineers, postmasters, mayors, river observers, bridge tenders, and water and sewer plant operators after a damaging flood. Returns are spot checked against newspaper accounts and occasional field observations. Although some of the information thus gathered is spotty and speculative, it is often the best if not the only flood damage data available.

Local Weather Bureau offices also provide flood forecasts and warnings for the areas within their jurisdiction. Accurate forecasting combined with fast and efficient action can substantially reduce flood damage and minimize the risk of human casualties from floods. Within the Tennessee Valley the Bureau under a cooperative arrangement supplies TVA with weather and quantitative rainfall forecasts and utilizes TVA's daily river stage forecasts in its warnings to the public.

In addition, the Weather Bureau is responsible for issuing warnings for hurricanes that approach the United States mainland. During the summer and fall forecast offices at San Juan, Miami, New Orleans, Washington, and Boston install special communications facilities and maintain careful watch for potential hurricanes. As soon as there are definite indications of a hurricane the Bureau begins issuing advisories and gives the storm a name. Hurricane watch notices and gale warnings are included in the advisories if the hurricane moves toward the mainland, and special bulletins are issued frequently for press, radio, and television. When a hurricane becomes a serious threat to North Carolina, detailed storm information is prepared by

the Raleigh Weather Bureau office and sent out by radio broadcasts at least once an hour over a network of more than 100 radio stations in the state.

U. S. Geological Survey--The USGS, a division of the Department of Interior, conducts cooperative programs with various state, Federal and local agencies for collection and analysis of data concerning water resources. Its North Carolina headquarters office is at Raleigh, and it maintains a network of cooperative stream gaging stations throughout the state. Although the USGS has no regular publications concerning floods, it has published some pertinent individual reports of considerable interest. The most extensive flood frequency analysis for streams in North Carolina is a USGS publication originally written by H. C. Riggs in 1955, and enlarged and revised in 1961 by William E. Forrest and Paul R. Speer, Floods in North Carolina, Magnitude and Frequency. This report analyzes flood stage and discharge data for 144 gaging stations. Noteworthy among special storm reports prepared by the USGS are Floods of August 1940 in North Carolina (Water Supply Paper No. 1066) and a cooperative report written by Dean Bogart in 1960, Floods of August-October 1955, New England to North Carolina. (Water Supply Paper No. 1420.) The latter is an exhaustive (854 pages) survey of the disastrous floods that followed hurricanes Connie, Diane, and Ione.

U. S. Forest Service--The Forest Service, a division of the U. S. Department of Agriculture, is responsible for administering the National forests, for forestry research, and for a number of cooperative programs with public and private forest landowners. Though not so directly involved in flood damage prevention programs as, for example, SCS or TVA, the Forest Service in many ways works toward reduction of flood damages through watershed protection measures. It cooperates in administering forestry phases of the soil bank and small watershed (PL 566) programs. It conducts research concerning the effects of forestry management on stream flow, soil properties and water quality. (This research is centered, in the Southeast region, at Coweeta Hydrologic Laboratory located in the Nantahala mountains of western North Carolina.) It administers cooperative fire prevention and pest control programs. It supplies seedlings for reforestation. In all of these activities the Forest Service is seeking to control erosion, to reduce siltation, and to improve the infiltration capacity of soils. While these measures cannot prevent the damage wrought by major floods, they do help to reduce the continuing toll of damage from minor to moderate flooding.



Other Agencies--TVA, SCS, and the Corps collect and analyze a great deal of flood damage information in addition to that which is reflected in the programs previously described. Some of this information is published in regular or special reports. Thus, SCS occasionally publishes special bulletins concerning damaging storms in watersheds that it has under study.<sup>6</sup> TVA will also occasionally publish special reports concerning major storms.<sup>7</sup> Lesser storms are covered in a regular monthly TVA bulletin, "Precipitation in the Tennessee River Basin."

### Regulatory Controls

Tennessee Valley Authority--Section 26A of the TVA Act prohibits the erection or maintenance of any "dam, appurtenant works or other obstruction affecting navigation, flood control, or public lands or reservations across, along or in" the Tennessee River or any of its tributaries, without prior approval of plans therefore by the TVA Board of Directors.

To administer this provision TVA has created a committee composed of three TVA officials. The "26A committee" reviews applications under the section and transmits its recommendations to the TVA Board of Directors for approval or disapproval. Printed instructions are furnished to applicants for 26A approval, prescribing in detail the required information. The applications that have been approved cover a wide range of overhead, floating, fixed, and underwater structures--bridges, dams, power lines, pipelines, buildings, boat docks, roads, and fills.

If the language of Section 26A were taken literally, and permission were required for every minor encroachment along the entire Tennessee River system, and for every small dam on an upstream tributary, the burden of administration would probably be disproportionate to any benefits that might accrue. For this reason TVA has applied these controls with some selectivity.

Section 26A has incidentally given TVA a control over all water resources development within the Tennessee Valley, including an opportunity to review developmental plans of other government agencies, such as SCS. It has thus played a significant role in the concept of unified development of the Valley.

U. S. Army Corps of Engineers--Congress has vested in the Corps of Engineers general statutory authority to regulate obstructions to navigable



waters of the United States.<sup>8</sup> Since this does not directly bear on flood control we merely mention it here as an instance of a related regulatory power.

### Insurance Programs

A subsidized, experimental flood insurance program was authorized by Congress in the Federal Flood Insurance Act of 1956.<sup>9</sup> However, the plan subsequently proposed for putting the program into effect was considered by Congress to be too indefinite and costly and funds were not appropriated to activate it. Public awareness of the need for flood insurance has remained strong as a result of recent damaging floods. Nevertheless, feasible techniques have not been developed by which insurance against flood damage can be offered to the greatest number of persons at a reasonable cost in a manner consistent with other means of flood damage prevention.

A limited program of farm crop insurance has been initiated, however, to protect farmers against losses from destruction of crops by floods and other unavoidable causes, such as drought, windstorm, disease and frost.<sup>10</sup> The purpose of the program is to insure against disaster and payments accordingly are limited to cash and labor costs. Coverage is limited to certain crops and is not available in all counties. (The list of covered crops includes tobacco, cotton, corn, soybeans, wheat, and several others.)

One result of the crop insurance program is to make the Federal Crop Insurance Corporation a useful source of information on agricultural flood damage. For example, when tobacco crops were badly damaged this spring by floods in Town Fork and Little Yadkin watersheds, the first informed public estimates of damage came from Crop Insurance Corporation officials.<sup>11</sup>

### Dam-Safety Measures

Several Federal agencies take steps to insure the safety of dams under their jurisdiction.

Federal Power Commission personnel review the design of structures proposed by licensees under the Federal Power Act in advance of construction for safety and adequacy of design. Licensees are required by the Federal Power Act and by the terms of the license to maintain project works in adequate repair. Inspections covering safety and performance of licensed projects are

made periodically. Projects in North Carolina are supervised by the FPC Regional Engineer's office in Atlanta.<sup>12</sup>

The Soil Conservation Service has developed routine procedures for reviewing the safety of farm ponds and flood retarding structures built with its assistance. Structures are graded according to size and degree of hazard. The larger structures entailing the greatest potential hazard to life and property must be approved by the State Engineer; smaller, less hazardous structures are designed or approved by SCS engineers or area engineers.<sup>13</sup>

The large multi-purpose reservoirs built by TVA and the Corps are of course carefully checked by these respective agencies from the point of view of safety of design and operation.

#### Other Preventive Programs

Federal agencies such as the Veterans Administration, the Federal Housing Administration, the Public Housing Administration, and the Urban Renewal Administration are effectively using flood information in processing home loans and in planning public projects. This action not only recognizes flood hazards and requires plans to provide reasonable safety from them, but also encourages state and local action.

Other programs of the Housing and Home Finance Agency (HHFA) also contribute to the abatement of the flood damage potential throughout the Nation. Those which are making the greatest contributions include:

HHFA "Section 701" funds for local planning assistance permit studies that lead to improved land use, zoning, and other regulation of developments in areas subject to flooding.

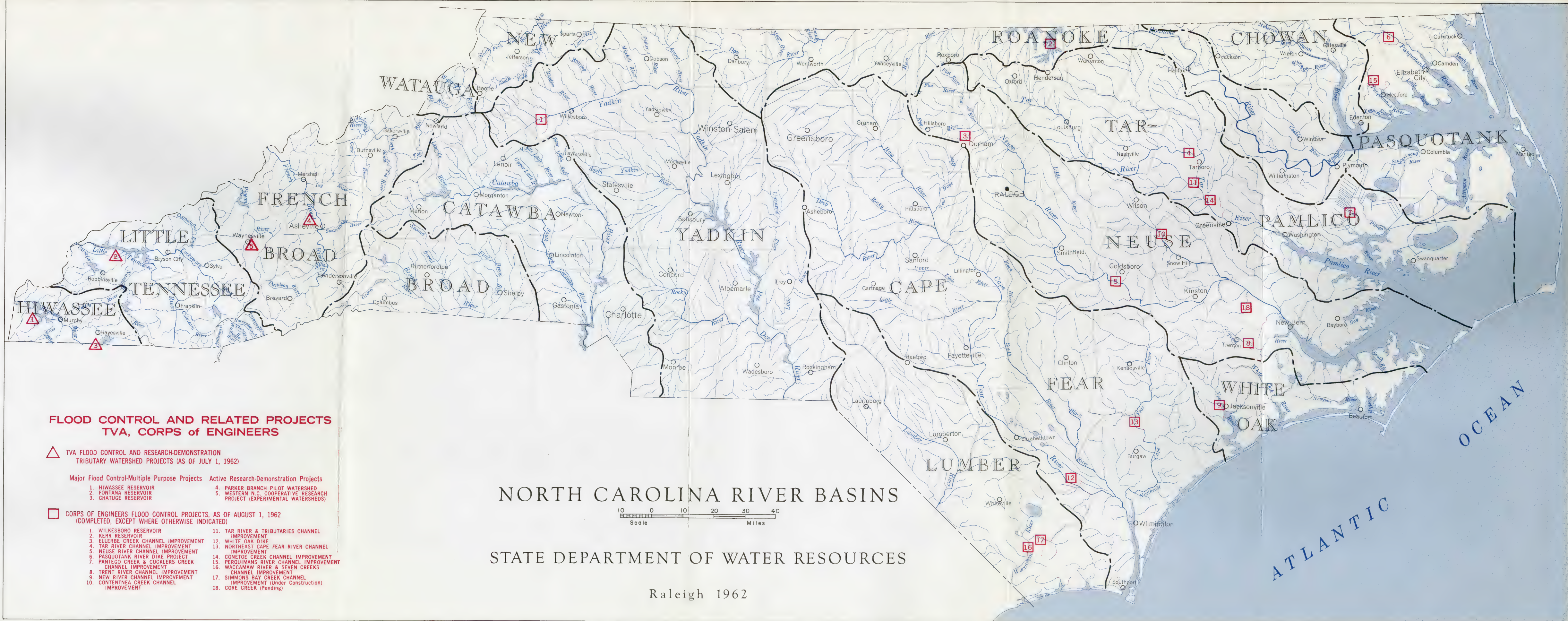
HHFA "Section 701" funds for state planning make it possible for states to play a greater role in flood damage prevention.

#### Corrective Programs

##### Flood Control Projects

Physical flood control measures--dams, dikes, channel improvements, and the like--are a familiar and established method of combating floods.









During much of our national history these measures were handled largely by local governments. Today, they are carried on and supported largely by the United States Government. In North Carolina the Federal agencies primarily involved are the Corps, the SCS, and the TVA.<sup>14</sup> It is to one of these agencies that the city dweller, farmer, or industrialist will ordinarily turn for help when he needs flood protection. In the pages that follow we will briefly review their respective flood control programs.

U. S. Army Corps of Engineers--The Corps of Engineers is the engineering branch of the Department of the U. S. Army. It is also the instrument chosen by Congress to carry forward the bulk of the Federal navigation and flood control improvements. The Corps plans, designs, and constructs all manner of flood control projects, ranging from minor snagging and channel clearance operations, and localized levees or dikes, through systems of major reservoirs controlling entire river basins for flood damage prevention and related purposes.

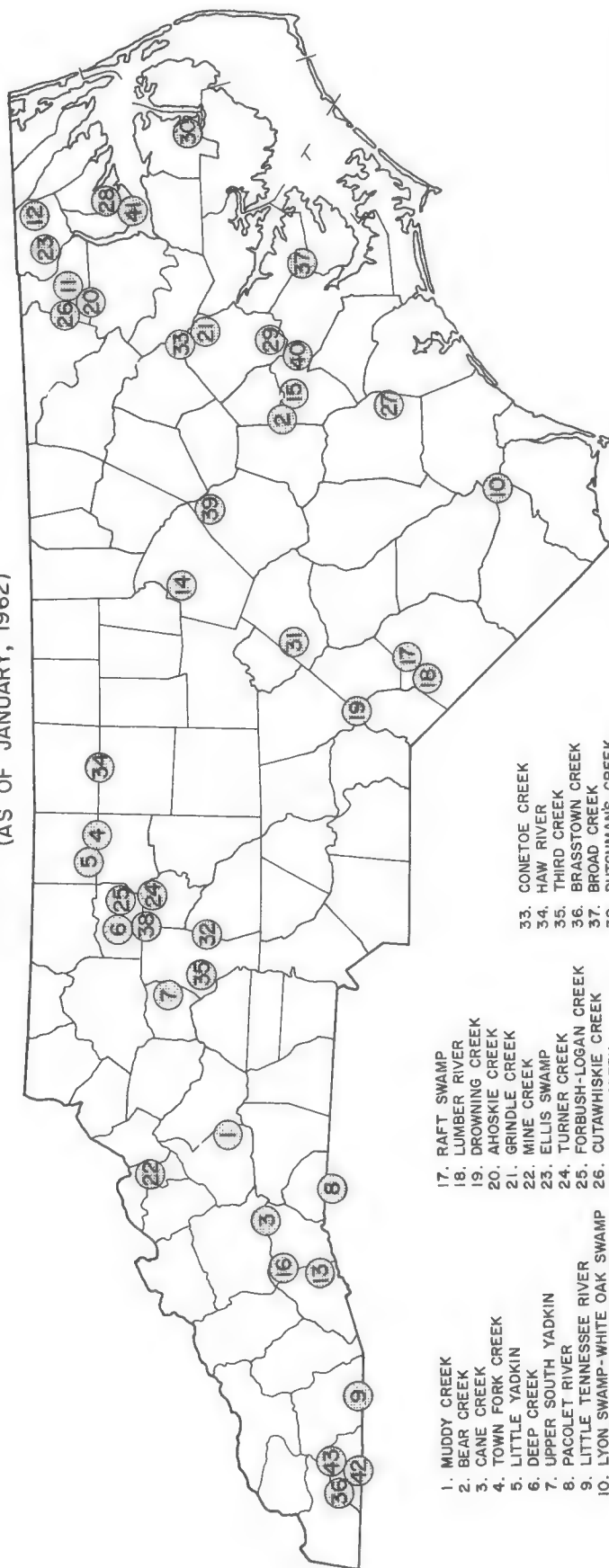
North Carolina is divided for administrative purposes into six Corps districts: Wilmington, North Carolina; Charleston, South Carolina; Nashville, Tennessee; Norfolk, Virginia; Savannah, Georgia; and Huntington, West Virginia.

A map showing Corps flood control projects in North Carolina will be found on page 33. In addition, North Carolina receives substantial flood control benefits from Kerr Reservoir and Philpott Reservoir, located in Virginia on the Roanoke River system. Also, comprehensive surveys are underway concerning the water resources of several major North Carolina river basins, which may culminate in construction of further reservoirs for flood control and related purposes.

It is of interest that the Corps several years ago instituted requirements in conjunction with flood control projects designed to stimulate greater local preventive activity. Thus, in its proposal for control of the Cape Fear River, the Corps requires that before actual construction begins local interests must agree to protect downstream channels from encroachment and obstructions that would adversely affect operation of the project. This is in accordance with the Corps policy that such project reports "will recommend that local interests adopt and give assurances that they will enforce appropriate regulatory measures relevant to project requirements."<sup>15</sup> In a letter to the author the District Engineer's office at Wilmington elaborated on the effects of the stipulation contained in the Cape Fear report, as follows:



# SCS SMALL WATERSHED PROJECTS (AS OF JANUARY, 1962)



1. MUDDY CREEK
2. BEAR CREEK
3. CANE CREEK
4. TOWN FORK CREEK
5. LITTLE YADKIN
6. DEEP CREEK
7. UPPER SOUTH YADKIN
8. PACOLET RIVER
9. LITTLE TENNESSEE RIVER
10. LYON SWAMP-WHITE OAK SWAMP
11. HORSE SWAMP-FLAT SWAMP
12. FOLLEY DITCH
13. FRENCH BROAD RIVER
14. CRABTREE CREEK
15. FALLING CREEK
16. MILLS RIVER

17. RAFT SWAMP
18. LUMBER RIVER
19. DROWNING CREEK
20. AHOSKIE CREEK
21. GRINDLE CREEK
22. MINE CREEK
23. ELLIS SWAMP
24. TURNER CREEK
25. FORBUSH-LOGAN CREEK
26. CUTAWHISKIE CREEK
27. MUDDY CREEK
28. BURNT MILL CREEK
29. JOHNSON MILLTAIL
30. GUM NECK
31. UPPER LITTLE RIVER
32. FOURTH CREEK

33. CONETOE CREEK
34. HAW RIVER
35. THIRD CREEK
36. BRASSTOWN CREEK
37. BROAD CREEK
38. DUTCHMANS CREEK
39. MOCCASIN CREEK
40. MOSLEY CREEK-TRACEY SWAMP
41. POLLOCK SWAMP
42. SHOOTING CREEK
43. TUSQUITEE CREEK

Notes: This map shows active small watershed projects approved for planning grants through 1961.

"Local interests," as far as the Corps is concerned, could be city, county, or state governments. It is believed, however, that appropriate action at the state level would be most desirable since the legislation would encompass other river basins in the State as well as the Cape Fear River Basin. . . .

[I]t is believed that the minimum amount of legislative action required would be that which would safeguard actual channel encroachment and an appropriate amount of zoning and regulation for lands lying below the 50-year regulated floodflow line.<sup>16</sup>

Soil Conservation Service--The Soil Conservation Service is a

division of the U. S. Department of Agriculture, created during the dust storm era of the '30's. The heart of its program has been an effort to educate farmers to preserve and improve their land by soil conservation and land treatment measures. At one time it was hoped that these measures alone, by improving the capacity of soil to absorb and hold water, could become an important new flood damage abatement weapon. Experience indicated, though, that they would not significantly reduce flood damage from major floods. So it was that the Soil Conservation Service--beginning with experimental and pilot projects during the '40's, and culminating with the adoption by Congress of Public Law 566 in 1954--came to regard the building of flood retarding structures as a necessary part of its program for the purpose of reducing flood damage.

Public Law 566 encourages farmers in small watersheds to cooperate in projects combining improved soil conservation practices with agricultural flood protection and water conservation measures. Under this law the Federal Government pays all flood prevention construction costs; pays part of water conservation construction costs (if any); provides planning assistance; and makes loans to help finance the local cost share. Local interests must initiate the projects; obtain easements and water rights; assume maintenance responsibility; and secure landowner agreements to carry out needed soil conservation measures.

There are some legal limits on the size of projects eligible for PL 566 aid. The largest watershed area that can be included in such a project is 250,000 acres. No single water retarding structure may impound more than 5,000 acre-feet of flood storage or 25,000 acre-feet total storage.

Public Law 566 planning grants had been sought for 48 small watershed projects in North Carolina as of the end of 1961. Six of the projects were inactive, and several others bordered on this classification. (See page 36 for map of active projects.) One additional watershed was initiated as a "pilot project" in 1953. Eighteen of the 43 active projects involved programs principally devoted to drainage improvement; the remaining 25 were small watershed projects with agricultural flood control as their primary purpose. Some degree of flood protection for urban property was planned for 8 projects, and at least 2 projects promised some municipal or industrial water supply benefits. Actual construction had been started or completed on 8 projects.

A typical piedmont or mountain small watershed project in North Carolina will involve a series of small water retarding structures providing for flood storage, a sedimentation pool, and perhaps limited water supply storage. Stream channels below the structures will be cleared and straightened. Farmers within the watershed will have initiated various soil conservation measures, and in critically eroded areas the government itself may have undertaken some such measures. The net result in terms of flood protection will usually be to lower potential flood levels within the watershed, thus reducing the risk of agricultural flood damage though not giving complete protection. In a mixed urban-rural watershed where floods appreciably endanger life, a somewhat higher standard of protection will be provided. (See chapter 11 for a detailed discussion of such a project.)

Tennessee Valley Authority--TVA has described its flood control system in the following terms:

"When TVA was created by Act of Congress in 1933 to develop the resources of the Tennessee River Basin, the principal water control objectives assigned to it were to (a) provide 9-foot navigation on the main Tennessee River from its mouth to Knoxville, Tennessee; (b) control destructive flood waters in the Tennessee and Mississippi River Basin; and (c) generate the maximum amount of electric power consistent with flood control and navigation.

In developing the reservoir system these primary multiple purposes have always governed. Being one of the major objectives, flood control has been in the forefront in planning, designing, constructing, and operating the dams and reservoirs.

Ten major multiple-purpose dams, up to several hundred feet high, have been built on the five major tributaries above Chattanooga. . . .

The nine dams on the main river are so located as to provide a continuous chain of slack-water pools which afford, at their lowest level, a minimum navigable depth of 9 feet from the mouth of the river to Knoxville. Storage space above this lowest level is provided in eight of these reservoirs for further regulation of flood peaks. . . .

On January 1 of each year the reservoir system has space reserved for the storage of nearly 12 million acre-feet of flood water."<sup>17</sup>

In addition to building these major structures, TVA has utilized at least three other distinct approaches to the problem of floods in the Tennessee Valley. One of these, its flood plain studies of local flooding problems, has already been discussed (see pages 21-25). Also reviewed earlier was TVA's effort to regulate channel encroachments under Section 26A of the TVA Act (see page 30). The third approach which for convenience we will label the "tributary area development program" (although it has gone under several names) will be described at this point.

#### TVA Tributary Area Development Program

This program is an intensification and unification of TVA's Valley-wide resource development activities through a concentrated effort by TVA with the local people and state agencies in tributary areas of the Tennessee Valley. The purpose of this program is not only the abatement of flood damages but to accelerate sound economic progress based on comprehensive unified development of all resources. The program includes research, demonstration, and development activities.

In each of the tributary areas the first step is a joint cooperative inventory of all the resources of the area in order to determine the stage of development and the potential of the area as well as to identify problems and opportunities.

The resource groups which are used in this initial examination include the following: human resources, land, water, agriculture, forests, minerals, recreation, business and industry, transportation and communications facilities, and public and private institutions and services.



Next, the findings of the inventories are jointly analyzed and evaluated. This provides the basis for identifying problems and opportunities and giving them quantitative and qualitative dimensions. This analysis is used as a basis for determining objectives and goals on which a cooperative resource development program including the prevention of flood damages can be developed, specific plans made, and the program implemented.

From the first step (inventory) local people participate through their resource work groups. These work groups are provided with technical assistance and guidance by TVA and state agencies. Participation of local people in the inventory and analysis stage gives them the background needed for participation in subsequent steps of developing and implementing programs for their areas.

The portion of the French Broad River watershed in North Carolina is included in this program. The inventory of resources is now under way. (For further details see pages 85 and 86.)

## CHAPTER 4

### EXISTING FLOOD DAMAGE ABATEMENT ACTIVITIES OF THE STATE GOVERNMENT IN NORTH CAROLINA

At this point we will consider the existing activities of the State Government in this field, and the legislative authorization for these activities. The state occupies an important position in programs of flood damage abatement and its activity or inactivity will often be decisive.

#### Flood Damage Abatement in General

##### Department of Water Resources

The general responsibilities of the North Carolina Department of Water Resources for flood damage abatement functions include:

Making studies and reports regarding shore erosion projects, dams, reservoirs, and channel improvements.

Advising public and private agencies concerning river works and watershed development.

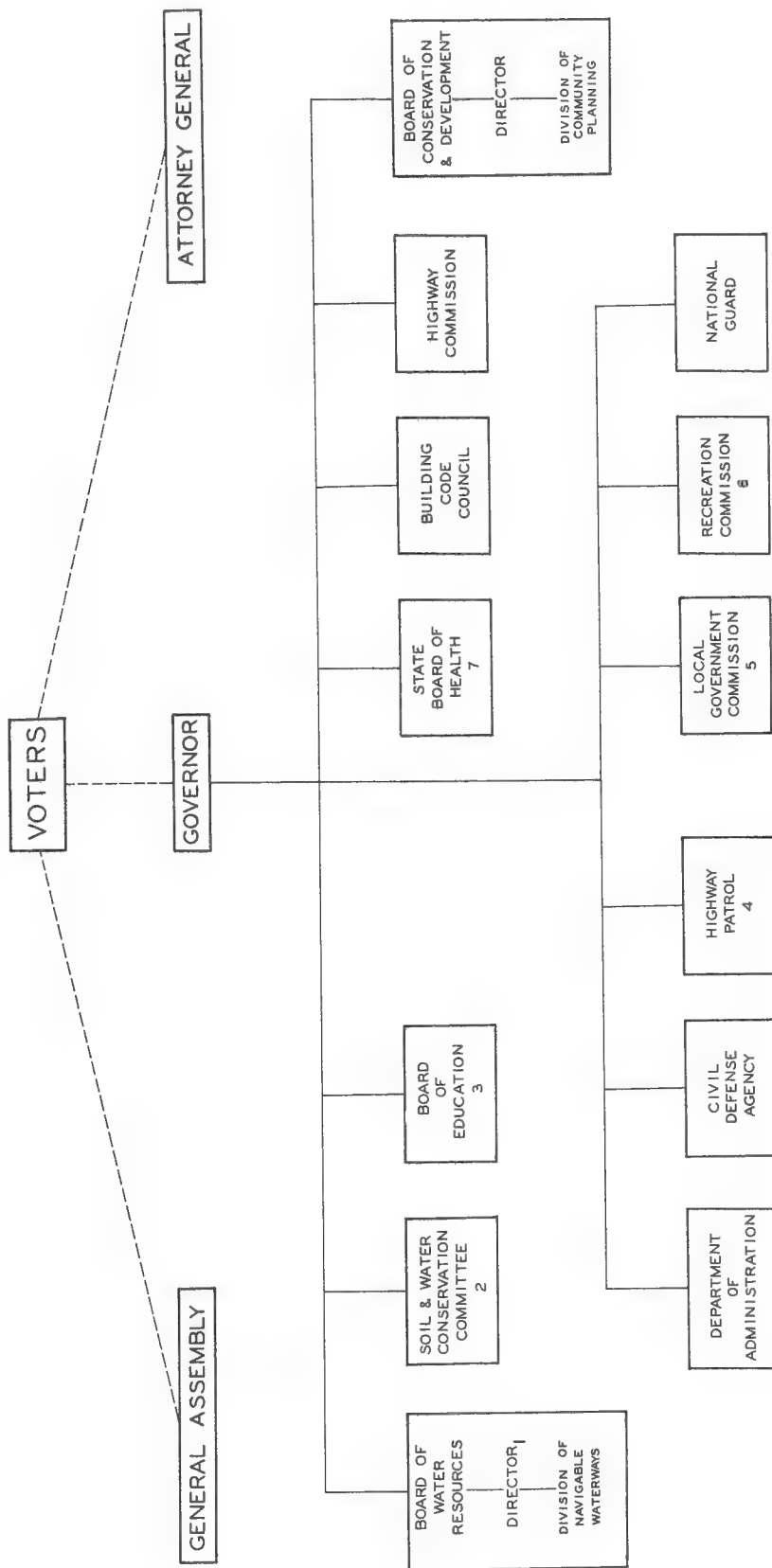
Cooperating with the U. S. Army Corps of Engineers in planning and developing flood control, hurricane protection, and shore erosion prevention projects.

Formulating and administering a program of dune rebuilding, hurricane protection, and shore erosion protection.

Requesting our Congressmen to seek appropriations for needed flood protection and shore erosion prevention projects.

Preparing and maintaining climatological and water resource records. Initiating, planning, and executing a long-range program for preserving, developing and improving rivers, harbors, and inland ports.<sup>1</sup>

Within the Department of Water Resources a Division of Navigable Waterways administers these functions and others in the field of improvement of navigation. (The very title of this division reflects the relative



**NOTES**

1—Appointed by Board with Governor's approval.

2—One appointed by Committee; remainder ex officio.

3—Three appointed by Governor with approval of General Assembly; 10 ex officio.

4—Supervised by Motor Vehicles Commissioner.

5—Five appointed by Governor; 4 ex officio.

6—Seven appointed by Governor; 4 ex officio.

7—Five appointed by Governor; 4 elected by State Medical Society.

### AGENCIES OF STATE GOVERNMENT PRIMARILY CONCERNED WITH FLOOD DAMAGE PREVENTION

**LEGEND**

----- Elected by voters.

----- Appointed or Supervised by Governor or other indicated authority.

priorities originally assigned to its twin activities of navigation improvement and flood control.) The Division currently consists of one full-time employee (its chief), one other professional employee who devotes part of his time to its work, plus secretarial help.

The Division focuses its efforts on liaison with Federal agencies administering flood control and flood damage prevention programs. In the field of flood damage prevention, for example, the Division receives and coordinates local applications for flood plains studies by TVA and the Corps--helping to bring the parties together, assisting the communities to prepare applications, and performing a preliminary screening function. The current focus of effort on liaison with Federal agencies has apparently paid off well in practical terms. During the brief period since the Department came into being there has been a considerable expansion of Federal flood control and flood damage prevention activities in North Carolina. While this can hardly be attributed solely to the state's efforts, the Department has obviously made its mark in the field.

#### Small Watershed and Drainage Programs

##### Board of Water Resources

The North Carolina Board of Water Resources has some supervisory responsibilities under the Small Watershed Law and the Drainage District Law.

Watershed work plans for Public Law 566 projects sponsored by counties or watershed improvement districts must be submitted to the Board of Water Resources for review as to safety of construction, among other things. The Board also has limited control over operation of such projects. In addition, the Board can require watershed improvement districts to keep records of stream flows above and below their impoundments, if funds are available for this purpose.

Under the Drainage District Law the drainage engineer on a drainage district board of reviewers is appointed on recommendation of the Board of Water Resources.

To date the Board has reviewed a total of six watershed work plans and appointed several drainage engineers. All of the final work plans submitted have been approved.



### Soil and Water Conservation Committee

The State Soil and Water Conservation Committee also has certain supervisory responsibilities over all small watershed programs. The State Committee's approval is required on all applications for planning assistance under Public Law 566, and the Committee recommends priorities on applications that are approved. In exercising its general supervision over soil and water conservation programs in the State, the Committee may have further contacts with small watersheds.

The State Committee has developed a general procedure for handling small watershed planning grant applications and has devised criteria which it uses in recommending priorities on the applications. Actual time spent by the Committee in reviewing applications is minimal. Through the end of 1961 the Committee had approved and recommended priorities for 32 applications. It had not disapproved any application, though one application was cancelled after approval.

The Committee's one-man staff--its administrative officer--has devoted on the average about one-third of his time to small watershed programs. His work includes reviewing applications that are to come before the Committee, attending local meetings concerning organization of small watershed projects, and assisting with local educational programs. The work of this office attributable to small watershed programs probably requires an average annual expenditure of about \$5,000.

### Local Government Commission

The Local Government Commission--which supervises local governmental borrowing in North Carolina--has the responsibility to approve watershed improvement district bond issues and to pass upon the form of indebtedness used. To date the Commission has not been called upon to exercise these powers, nor has the exact nature of its mandate been clearly defined.

### Public Facilities

Various state agencies encounter flood problems in building and maintaining public facilities. We will discuss school and highway construction

as the most significant illustration of the flood damage problem in its impact on public facilities.

### Schools and Highways

The State Highway Commission and the State Department of Public Instruction are inevitably confronted with flood damage problems through the public highway and public school construction programs. (The Department of Public Instruction does not directly control school construction or school site selection, but it does have the opportunity to advise on these matters.)

Flood damage as it affects schools and highways poses a two-way problem. Schools and highways located in flood plains are susceptible to flood damage; at the same time, if they obstruct natural floodways they may complicate or enlarge the flood damage risk for others.

State school and highway officials are aware of this double-edged problem. Both take the risk of floods into account as a factor in selection of sites and construction methods. The Highway Commission has regular arrangements with the U. S. Geological Survey for studies of flooding and surface drainage conditions. State school officials have good working contacts with the State Department of Water Resources. Highway and school officials make use of TVA, Corps and SCS flood studies where available.

Two examples of the tangible value of good coordination are worth citing. The regular contact between the water and school agencies recently facilitated identification of a serious flood damage risk in connection with a proposed Madison County school expansion. A study by the Department of Water Resources resulted initially in modifications of location and plans that would significantly reduce the risk, and eventually in cancellation of plans for additions in the flood plain. Further upstream on the French Broad River, a proposed major highway location would have seriously conflicted with an important potential multiple-purpose dam site. TVA officials spotted this in time and, with the help of the State Water Resources Department, brought about a slight change of location which resolved the potential conflict.

## State Planning Programs

### Local Planning Assistance

The Division of Community Planning of the Department of Conservation and Development is the state's agency for providing local planning assistance. Its work involves planning assistance through staff or consultant services to counties, cities, and towns as well as administration of Federal "701" local planning grants.

About one-fourth of the staff is supported by state appropriations and handles the state-wide responsibilities of the Division. The remaining three-fourths of the staff is financed by receipts under contracts with localities being given planning service--that is, by Federal planning grants and local matching funds. To an increasing extent the staff members associated with local planning work are performing a continuing staff function rather than merely offering a consulting service for the purpose of producing package plans.

In their work Community Planning personnel are in a position to point out flood problems to local officials and to suggest preventive action via zoning, subdivision and building controls or other means. That some efforts are being made along these lines is reflected by the inclusion of flood plain restrictions in zoning ordinances recently prepared by the Division for Kinston and Elizabeth City. Undoubtedly there will be further opportunities for this in the future, especially in areas covered by Corps of Engineers or TVA flood plains studies. More consistent attention to the problem by the Division should yield greater results than hitherto.

The scope of the Division's activities is indicated by the size of its rapidly growing staff--44 planners, draftsmen, and other employees as of June 1962. These personnel operate out of offices in Raleigh, Salisbury and Kinston. The bulk of its budget is derived from Federal aid and local matching funds with less than 30% from state appropriations.

In the western portion of the state the Division's work is supplemented by the Western North Carolina Regional Planning Commission, as described on page 55.

## Planning for State Government Operations

An active state planning agency could participate in and implement a state flood damage prevention program--for example, by evaluating proposed floodway encroachment lines or land acquisitions in terms of their over-all effects on state government.

The Department of Administration has the authority to undertake a long-range state planning program that could logically include a plan for flood damage prevention. Among other things this Department is authorized to collect and analyze data concerning industrial and agricultural development, urbanization, and natural resources. It is also empowered to make special studies of land use and related matters.<sup>2</sup> These powers lie dormant, however, as the Department has never activated this potential state planning program.

The Division of Community Planning is now specifically authorized by statute to undertake only those state-wide planning studies "which may be necessary as a basis for related studies conducted for municipalities and counties or for joint and regional planning boards."<sup>3</sup>

## Dam Failures

The special problems posed by the risk of dam failures were discussed in chapter 1. There are some scattered state functions that touch upon the area of regulation of the safety of dams, but no coordinated or focused effort. The Department of Water Resources, as noted earlier, is authorized to review small watershed work plans for safety of construction. The Sanitary Engineering Division of the Board of Health inspects municipal impoundment plans for water treatment purposes, and the Stream Sanitation Division inspects impoundment plans in connection with waste treatment plants. The State Highway Commission seeks to control the risk of failure or leakage of impoundments that might affect public highways.

## Other State Activities

Several other state agencies make some contribution to flood damage prevention measures.



### Building Code Council

The State Building Code Council is responsible for adopting and maintaining the State Building Code. This code, though not currently applicable throughout the state to all forms of construction, is potentially applicable to virtually all significant building construction in the state. (Subsection (e) of GS 143-138 makes the State Building Code applicable statewide when it was adopted, but empowers any political subdivision to adopt its own code or regulations, subject to the approval of the Building Code Council. An earlier part of the same section, subsection (b), provides however that the State Code shall not apply to one or two family dwellings, or to small temporary construction sheds, until accepted by the appropriate local governing body.) Through this code the Council is in a position to adopt or recommend regulations that will make buildings and their contents less vulnerable to flood damage. In addition to the effect of the code itself, there are opportunities to help localities with their individual problems. Thus, the staff of the Council has recently consulted with coastal communities on building requirements to ensure storm-resistant construction.

### Recreation Commission

The State Recreation Commission advises local and state officials on public recreation programs. In this capacity it often is in a position to encourage public acquisition of flood hazard areas as park or recreational sites, thus forwarding two public objectives simultaneously.

### Civil Defense Agency

The State Civil Defense Law provides that certain emergency civil defense powers of the Governor and of local civil defense organizations can be made applicable to natural disasters, including floods. These powers have never been exercised in an emergency arising solely from flooding.

Where floods have caused a major disaster, the President of the United States on request of the Governor may declare the stricken area a "major disaster area." This makes the area eligible for relief funds from the President's Disaster Relief Fund and for assistance from various Federal agencies. The State Civil Defense Agency handles this relief program for the state.<sup>4</sup>

## Other Agencies

Other state agencies are periodically affected by serious flooding. For example, the State Board of Health may be called into action by floods that contaminate sources of public water supply. A recent illustration is the Ash Wednesday (1962) gale that caused pollution of water supplies in Dare County. State troopers and national guardsmen may be called in to patrol and protect flood disaster areas.

## State Expenditures for Flood Damage Prevention

In addition to the activities described in the preceding pages, the State of North Carolina has made some substantial financial contributions in recent years to cooperative programs supported primarily by Federal funds. These contributions include:

A 1961 appropriation of over \$175,000 to expedite the planning of small watershed projects.<sup>5</sup> These funds were used principally to employ a second "planning party" for small watershed programs in North Carolina, thereby enabling SCS to double its working force in this area. The funds also included a small contribution toward defraying small watershed organizational expenses.

Expenditures of approximately \$17,000 during fiscal year 1961 for flood studies under U.S.G.S. matching fund programs. Comparable expenditures have been made for this purpose in recent years.

An authorization of \$150,000 from contingency and emergency funds to help meet the non-federal cost share on Corps of Engineers shore protection projects.<sup>6</sup> The authorization was never utilized and consequently expired by its own terms at the end of the 1959-61 biennium (June 30, 1961).

An appropriation of \$600,000 for preservation of that part of the Outer Banks extending from Ocracoke Inlet to Cape Lookout, to be expended for land acquisition and engineering studies.<sup>7</sup>

As of June, 1962, the following expenditures had been made by the state under this appropriation:

- (a) \$60,000 in cash and services for a cooperative Federal-State study of methods of protecting the Banks;
- (b) \$105,000 for construction of experimental sand fencing as a means of building dunes on Portsmouth Island; and
- (c) approximately \$285,000 for land acquisition, with the intent of acquiring the ocean frontage on Portsmouth Island and Core Banks to a depth of 750 feet from high water mark. Another \$115,000 is available for land acquisition.

A 1959 appropriation of \$150,000<sup>8</sup> and previous expenditures of \$50,000 by the Department of Conservation and Development for restoration and protection of Fort Macon Park.

The District Engineer's Office of the Corps at Wilmington has drawn from these developments the conclusion that "There is ample reason to believe that the State of North Carolina has subscribed to a permanent policy of financial assistance for water resource development."<sup>9</sup> Whether or not such an inference is warranted, the record does make clear that the State of North Carolina has made generous contributions in recent years to a wide variety of cooperative flood damage abatement programs, including preventive and corrective measures, as well as planning activities.

#### Summary

To summarize--

(1) Several state agencies are now engaged in flood damage prevention activities. The Department of Water Resources performs liaison functions in connection with Federal flood plains studies and Federal flood control projects, and is actively seeking to initiate a broader program of flood damage prevention. The Division of Community Planning through its local planning assistance work has encouraged and aided a few communities to adopt local flood plains regulations, and is in a position to continue and expand this role. The Building Code Council makes a similar contribution on a smaller scale in the field of local building regulations. Several other agencies either have unused authori-

to participate in some phase of flood damage prevention, or are involved mainly as potential beneficiaries of flood damage abatement programs rather than in formulating or administering such programs.

In sum, the state government with limited funds and authority has laid the foundations for a program of flood damage prevention. As will be seen in chapter 6, North Carolina hardly ranks now as a leader among state governments in this field. However, given adequate funding and certain new enabling powers, North Carolina could move rapidly into a position of leadership here.

(2) In addition to these agency activities, the State of North Carolina has in recent years made several financial contributions to various phases of cooperative flood damage abatement programs, totaling in the neighborhood of one million dollars.

(3) Apparently there is today no significant duplication or overlapping of efforts in the field of flood damage prevention. Although good working ties exist between the agencies most concerned with flood damage prevention, there are some gaps in program coordination, principally in the absence of any mechanism for routine general interchange of information among all of the affected organizations.





## CHAPTER 5

### EXISTING FLOOD DAMAGE ABATEMENT ACTIVITIES OF LOCAL GOVERNMENTS IN NORTH CAROLINA

#### Introduction

Local government like state government occupies an important position in programs of flood damage abatement.

On the preventive side, the actions of local government will often be crucial to such programs. The state has delegated the power to regulate and plan for land use to local governments. Sometimes it may not be feasible to regulate the use of flood plain land; in these situations public acquisition of the area may prove the best way of curtailing flood damage. Here again, local government can play a leading role by acquiring flood-prone areas for open space or recreational uses.

On the corrective side, local governments--cities, counties, and special districts--perform two significant functions. They are frequently responsible for maintenance of projects installed by Federal agencies. In some cases they also help to finance projects.

This chapter will review the existing flood damage abatement activities of local governments in North Carolina, focusing first on preventive measures and then briefly discussing corrective measures.

#### Preventive Activities

##### Local Land Use Planning and Regulation Programs

City and County Planning--Land use planning and regulation can fairly be termed the building blocks of flood damage prevention. Without an active planning program, it will be difficult to identify the areas where preventive action is needed. Without effective land use regulation in these areas, or some adequate alternative, we will go on creating future flood damage problems.

In North Carolina the power to adopt zoning ordinances, subdivision controls, and building regulations has been delegated to cities and counties.



General laws of state-wide application give cities zoning and subdivision control jurisdiction within their boundaries, plus one mile extraterritorial jurisdiction. (GS 160-172, 160-226, 143-138.) Cities have no extraterritorial building code powers by general law. Some cities have more extensive extraterritorial zoning, subdivision control and building regulation jurisdiction under special acts. Most counties may adopt zoning, subdivision, and building regulations to be applied outside of municipalities; their coverage may include municipalities consenting thereto. (GS 153-266.1, 153-266.10, 143-138, 153-9 (52).) A few counties lack these zoning and subdivision powers, having been excluded from the enabling legislation. (Some technical problems arising out of the adoption of a separate flood plain zoning law in 1957 are discussed in the chapter on legal problems. See pages 70 and 71.)

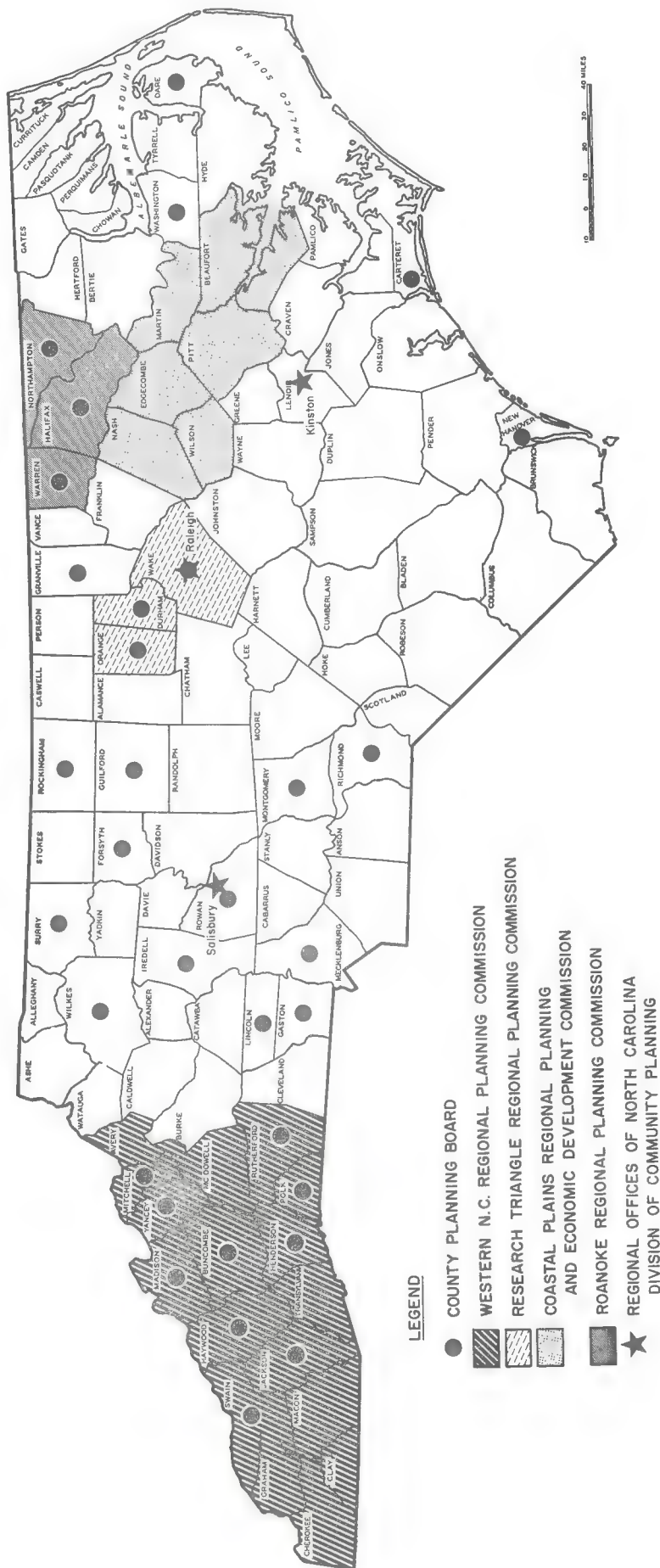
In July 1962 there were approximately 142 city or town planning boards and 32 county (or joint city-county) planning boards in the state. (Figures derived from informal records kept by the Institute of Government, based mainly on newspaper clippings.) These are shown on the maps at pages 54 and 56. It is not known how many of these planning units have exercised their zoning, subdivision, or building regulation powers.

These figures document what is well known to close observers of local government: That there is a vigorous local planning movement in present-day North Carolina. This movement supplies the foundation for effective local programs of flood damage prevention.

Regional Planning--Supplementing these city and county planning programs is a related development of recent origin--regional planning. At least four regional planning agencies affecting 29 counties have been established in the state. These are the Research Triangle Planning Commission, the Western North Carolina Regional Planning Commission, the Roanoke Regional Planning Commission, and the Coastal Plains Regional Planning and Economic Development Commission (see map at page 56). The focus of their activities varies from general economic development and regional planning coordination, to absorbing the impact of a particular local development, such as the construction of a large reservoir or industrial park. These commissions have no zoning or other regulatory powers. However, they do have active planning programs, competent technical staffs, and established contacts with the city and county planning agencies and governing boards of



# STATE, COUNTY & REGIONAL PLANNING AGENCIES (AS OF JUNE, 1962)



their areas. At least two of the commissions have already had some dealings with local flood damage problems. The facilities of these regional planning agencies could undoubtedly be utilized to help identify flood hazard areas and formulate flood damage abatement programs.

#### Flood Plain Regulations Actually Proposed or Adopted

While the record of flood plain regulations now on the books of North Carolina is not imposing, some beginnings have been made. Flood plain regulations known to the author to have been adopted or proposed for localities include:

Existing flood plain zoning restrictions in Elizabeth City limiting land use in a prescribed area essentially to recreational purposes.

Existing building code provisions in Carolina Beach, Wrightsville Beach, Nags Head, and Dare County, modeled after a code originated in Dade County (Florida), which require storm-resistant construction.

Existing subdivision controls adopted by Charlotte in October 1962, forbidding subdivision of residential building lots on land subject to flooding as often as once in 20 years.

Existing subdivision control policies in Greensboro, which require developers to provide a rather complete handling of storm drainage problems. This includes underground piping, curb and gutter, catchbasins, and open-ditch drainage. In the case of open-ditch drainage a substantial easement is required for maintenance, frequently amounting to a parkway between two paved streets.

Existing subdivision control policies in Raleigh, which encourage dedication of flood hazard areas and seek to discourage building below known flood elevations. In one recent instance a developer was persuaded to fill above a flood elevation. (The area was promptly flooded because the floodway had been constricted by earlier filling of the opposite bank.) Some developers have been persuaded to

include flood warning lines on their subdivision maps in order to place prospective purchasers on notice of the risk of flooding.

Proposed subdivision ordinances for Catawba, Iredell, and Lincoln Counties, which would require a setback line for lake frontage lots of 25 feet (horizontal from lake) and 3 feet (vertical, above lake level).

A comprehensive flood plain zoning plan proposed for Charlotte at one time, but not currently being pressed.

Zoning restrictions proposed for Hendersonville in 1959, described in the case study chapter on the Upper French Broad Basin (see page 80.)

Proposed zoning restrictions in Kinston, establishing special districts for flood hazard areas with special limitations on setbacks, elevations, building height, and lot coverage.

Flood plain zoning restrictions that have been suggested for the Crabtree Creek flood plains in Raleigh as a possible adjunct to a small watershed project. (See case study chapter on Crabtree Creek, page 100.)

A proposed building code amendment to control individual home building in flood plains in Charlotte (authorized by a special city charter provision).

#### Municipal Land Acquisition

Public land acquisition of flood hazard areas may also serve as a means of flood damage prevention. This may be the case, for example, where the land is to be devoted to purposes that are not susceptible to serious damage by flooding, such as open space, parks, or recreational use.

A number of cities and towns in North Carolina have obviously done this, some of them long before the subject of flood damage prevention was ever broached. While no official statistics are available reflecting the extent of this practice, it is obviously fairly widespread--witness the familiar creekside municipal park. The knowledge that the use of flood

prone areas for park purposes will also help to control potential flood damage should serve to bolster efforts to expand municipal park holdings.

Flood plain land may be acquired in a variety of ways and for a variety of purposes. The land may be purchased or obtained without cost by gift or dedication. Flood damage prevention may be the principal reason for acquisition or merely an incidental by-product of acquisition for some other purpose, such as public recreation. Acquisition may be complementary to flood plain regulation. Under certain conditions it may serve as an alternative to regulation.

Two different policies toward flood plain land acquisition are illustrated by Greensboro and Charlotte.<sup>1</sup>

Greensboro has acquired substantial areas of creek bottomland by dedication or gift, though never yet by purchase. Thus, from March 1960 to March 1962, 44.57 acres of bottomlands, designated for parks and storm drainage, came to the city through dedication on subdivision plats. Currently Greensboro planning officials are seeking the dedication of a reasonable amount of low-lying property to be designated for park and storm drainage purposes, while proposing in appropriate circumstances to buy some adjacent higher land for park purposes. In this way, it is hoped to identify land of zero market value for dedication and to pay for higher ground with alternative uses which give it real value.

The Charlotte-Mecklenburg Planning Commission has very recently proposed that bottomlands subject to flooding be gradually acquired by the city and county as these areas become ripe for subdivision. The procedure would be rather simple. When a subdivision involving flood plain lands is presented for approval, the flood plain portion would be disapproved and purchased by the city or county, to be converted into recreational and park use as needed.

The most promising application of a policy such as Greensboro's probably lies in two areas: First, where the properties involved have little value in alternative uses because of poor drainage, frequent flooding, unsatisfactory lot size or terrain, and the like; second, where the developer may prefer to dedicate to the city creekbottom property adjacent to a proposed street rather than pay a relative large street assessment. A policy of purchasing flood plain land, as proposed in Charlotte, might be preferable



if on balance this appeared to offer the best long-term answer for meeting park and open space needs or for avoiding residential and commercial development of flood plain areas.

#### Other Local Programs

Public Facilities and Urban Renewal--City and county governments can of course help to reduce flood damage potential by careful selection of sites and construction of public facilities. This includes streets, bridges, and utilities, as well as schools, other public buildings, and urban renewal projects. There is an obvious opportunity to minimize direct damage to the facilities themselves, as well as to channel-induced residential and commercial development into areas not subject to flood damage.

Examples of the benefits of careful selection of school and road locations and construction methods have already been cited in the chapter on state activities (see pages 46-48). A recent case in point involving urban renewal occurred in Fayetteville. In this instance a flood hazard affecting a large part of an area proposed for urban renewal in southeast Fayetteville was brought to light by a general neighborhood plan prepared by the city planning department. As a result FHA refused to guarantee mortgage loans in the area. This caused the project to be terminated. Of course, this was a disappointment to the project's backers, but it was surely to be preferred to installation of an expensive renewal project that would be subject to serious flood damage.

#### Corrective Activities

As was noted in chapter 2, physical flood protection was once treated as a local problem--such protective works as existed were built under local auspices. This, of course, is no longer true. Today the Federal Government builds or finances most flood control works, frequently leaving to local governments the task of maintenance, and sometimes requiring a local contribution to the capital cost.

In North Carolina, local participation in flood control measures comes about principally in connection with small watershed projects and with small flood control and shore protection projects of the U. S. Army Corps of Engineers.

### Small Watershed Projects

The "small watershed" program of the Soil Conservation Service under Public Law 566 was described in chapter 3 in terms of the role of the Federal Government. Here we will merely fill in a few details concerning local participation.

Public Law 566 requires that a qualified local organization initiate small watershed projects and assume responsibility for obtaining easements and for maintenance. The North Carolina General Assembly in 1959 passed enabling legislation providing three avenues for this local participation: watershed improvement districts, county watershed programs and drainage districts. Watershed improvement districts may be created within soil conservation districts to carry out the local responsibilities required by Public Law 566, with benefit assessment financing. Or, counties may underwrite the program, using ad valorem tax financing with the approval of the voters of the county. Drainage districts, which like watershed improvement districts depend on benefit assessment financing, may also serve as local organizations.

Forty-three small watershed projects were being organized or actively considered in the State as of January 1, 1962. (For locations, see map at page 36.) Local organizations contemplated for these projects were: 21 drainage districts, 7 watershed improvement districts, 8 county watershed programs, and 8 unknown. Twenty-six of the projects were typical upstream flood protection projects; 18 were basically drainage projects. Eight of the active projects would supply some urban flood protection and at least two involved some municipal or industrial water supply benefits.

### U. S. Army Corps of Engineers Projects

The Corps has historically required more extensive local participation on small flood control and beach erosion control projects than on its major multiple-purpose projects. For local protection projects involving dikes and channel improvements, local interests are required to furnish easements and utility and highway relocations, indemnify the Corps against damage claims, and assume maintenance responsibility. In some instances localities are also required to share in installation costs. For example, substantial local contributions would be required on projects under consideration for the Carolina Beach and Wrightsville Beach areas. (See

chapter 9.) The Carolina and Wrightsville Beach projects would fall under authorizations that require some local financial contribution toward installation costs.

Typically the local sponsors of small Corps projects have been cities, counties, or drainage districts. Occasionally the state has assumed the responsibilities required of "local interests," as in the case of the \$150,000 authorization made in 1959 to use Contingency and Emergency funds for shore protection work (see page 49). In one recent instance a unique special district with ad valorem taxing powers, "Kelly Dike District" was created by special act of the General Assembly to act as local sponsor for a Corps project to extend and repair White Oak Dike.<sup>2</sup>

The locations of all Corps flood control projects in North Carolina, including its small flood control and shore protection projects, are shown on the map at page 33.

## CHAPTER 6

### EXISTING FLOOD DAMAGE PREVENTION PROGRAMS OF OTHER STATES

#### Introduction

This chapter examines the experience of other states which have adopted more extensive flood damage prevention programs than North Carolina. The programs reviewed are predominated by regulatory measures, such as state floodway encroachment laws and dam-safety laws. Other elements noted include tax incentives and warning signs. The chapter concludes with a brief review of the experience of several states in administering their programs.

#### Earlier Works on the Subject

A thorough study of the subject of controlling development in flood-hazard areas was published by Francis Murphy in 1958: Regulating Flood-Plain Development.<sup>1</sup> State floodway encroachment and dam-safety laws are reviewed at length, as are local flood plain regulations. Other preventive measures are noted in less detail. The operation and enforcement of existing laws and ordinances are examined and appraised. Although some portions of the report are beginning to be out of date, it is altogether the most valuable and comprehensive source of information on the subject.

#### Elements of State Flood Damage Prevention Programs

##### Floodway Encroachment Laws

Murphy reported a total of seven states as having enacted laws regulating encroachments on stream channels or flood plains. Reviewing the statutes to bring his list up to date, we found a total of 11. Murphy referred to these laws as "channel encroachment laws," a term in common usage at the time he was writing. In this report the slightly broader terminology "floodway encroachment" is used, because some of the laws reach out to restrict the use of a portion of the flood plain as well as the channel of a stream.



The substance of these laws is to prohibit the erection of structures, encroachments, or obstructions within natural floodways or stream channels without authorization to do so from a designated agency. Some of the statutes seek to control obstructions within the normal high water mark; others, to control obstructions within all or part of the "floodway." Thus, the Iowa law empowers the Natural Resources Council to establish "council floodways" including portions of the flood plain needed for efficient discharge of floodwaters. The Indiana statute includes a similar "commission floodway" procedure, as well as a self-effecting provision prohibiting erection of obstructions which would adversely affect or unduly restrict the capacity of the floodway. The Massachusetts and New Jersey prohibitions apply only to obstructions below high water (or "ordinary" high water) mark.

Murphy looked beyond the statutory language into the actual operation of these laws. He found that, as interpreted, the scope of the statutes varied from merely prohibiting obstruction of the channel, to prohibiting encroachment on the portion of the flood plain hard hit by historic floods as well as the channel.<sup>2</sup>

Enforcement--Reviewing the enforcement of the state legislation on the books Murphy found a record of spotty performance, at best. He commented:

It cannot be assumed that once a channel encroachment law has been passed the problem has been solved. Such an assumption was made by the Massachusetts Legislative Research Council in 1956. Development continues to take place that is serious encroachment during moderate and major flood flows, and the enforcement procedure for even such minimal channel lines is inadequate to serve the purposes of the act.<sup>3</sup>

These reflections should serve warning that effective encroachment control demands sufficient planning and enforcement funds, as well as passage of a law on the subject.

#### Laws for Protecting Coastal Areas

The State of Maryland in 1961 adopted legislation considered necessary to protect and preserve its coastal areas. A major part of the regulations deals with the preservation of sand dunes which are all-important

in protecting tidal areas from the devastating winds and waves during storms. Other states are considering similar action at the state level for the preservation of the public health and safety in their coastal areas.

### Dam-Safety Legislation

Murphy reported that some 29 states had adopted laws providing for licensing or inspection of dams in the interest of public safety. In a check of the statutes of all 50 states made in 1961, the author identified approximately 28 laws of this description. The slight discrepancy is unimportant; in any event, it is obvious that this subject has been a source of considerable legislative concern.

Typically, state dam-safety laws require a state official or department to approve plans for construction, alteration or repair of dams. There are usually some exemptions based on the size of the dam or its purpose. For example, all farm pond dams (or those under a certain size) may be exempted. Or all dams less than 10 or 15 or 25 feet high, or impounding reservoirs less than 5 or 10 or 100 acres in extent, or having a drainage area of less than one-half or one square mile, may be exempted.

Some of the statutes spell out procedures under which repairs or changes in dams can be compelled by a public agency for reasons of public safety. Some establish procedures for private complaints concerning unsafe dam conditions to be heard by a local or state official or board.

The actual operation of these measures can be illustrated by the experience of three states.<sup>4</sup>

Connecticut law requires its Water Resources Commission to inspect existing dams (and to license proposed dams) which by breaking might endanger life or property. The Commission has in recent years licensed an estimated 100 to 150 new dams each year, after an inspection by its staff. It also is in the process of inspecting existing dams, town by town, about 40 of 169 towns having been inspected. In this case the Commission's Engineer locates and briefly inspects the dam and later refers those requiring further inspection to a private consultant for a detailed survey. Orders are issued for repair or removal pursuant to the consultant's recommendation. About 50 such orders have been issued and in a substantial portion of these cases state personnel have repaired the dam in exchange for public access.

In Pennsylvania the Division of Dams, Encroachments and Water Allocation of the State Department of Forests and Waters is responsible for issuing permits for dams with a watershed larger than one-half square mile or which might endanger life and property. The Division in recent years has inspected and issued permits for 40 to 50 dams annually. On one occasion it obtained an injunction against an owner who altered his dam without a permit.

The Maryland Water Resources Commission is responsible for issuing dam permits after inspection of plans. Detailed safety inspection of plans is made for dams of more than 10 feet in height or one million gallons storage capacity. Only two or three such plans are approved each year.

### Zoning Regulation by States<sup>5</sup>

Regulation by states (as distinguished from local regulation) has usually been limited to encroachments upon stream channels and their immediate environs. Further control of encroachments in flood plain areas has generally been left in the hands of local zoning authorities.

A pair of exceptions to this pattern should be mentioned.

One consequence of this approach has been to leave unprotected some areas that are temporarily beyond the reach of city zoning jurisdiction and not controlled by county zoning. This may serve some good purpose as a stimulant for effective county zoning and planning. Be that as it may, this gap in land use control has prompted a proposal in Tennessee to empower the State Planning Commission to adopt zoning regulations applicable within flood hazard areas currently unserved by any local planning agency.<sup>6</sup>

The State of Hawaii has established a framework for land use regulation which gives the state government an important role in the zoning process. A State Land Use Commission was created in 1961, and was empowered to divide the state into three major districts of land (urban, agricultural and conservation) and to prescribe permitted land uses within each district.<sup>7</sup> Within these over-all classifications, actual zoning restrictions and locations would be determined by counties.

### Taxation

Some states permit a property tax adjustment to reflect depreciation in property values by flood and other natural causes. (North Carolina has a

statute permitting a taxpayer whose property is damaged by windstorm during the three-month period subsequent to the tax day to apply for a property tax reduction. N.C. G.S. 105-405.) The State of Hawaii permits deductions from income taxes of property losses from floodwater damage not compensated by insurance, either in the year the loss is incurred or in five installments.<sup>8</sup>

### Warning Signs

In at least one state, New Jersey, legislation has been proposed to authorize a state department to delineate and mark flood hazard areas.<sup>9</sup> The purpose or need for legislation on the subject is not clear--whether to limit or clarify the authority to erect signs; or because of some bearing upon potential state liability in connection with such action; or, perhaps, simply as a convenient means of publicity.

A similar provision is contained in section 2(b) of the Interstate-Federal Compact for the Delaware River Basin.

### Public Acquisition of Flood Hazard Areas

Murphy briefly comments on public acquisition of flood hazard lands as a promising method of regulating development and controlling flood damage.<sup>10</sup> He cites no instances of land acquisition by state governments, but refers only to instances of acquisition by Milwaukee County (Wis.) and Des Moines (Iowa) of land for park areas.

### Planning and Administration of Programs

The activities that have been reviewed in this chapter are usually administered by small divisions or sections of state departments of water resources or natural resources, or by the state engineer. At least one state, Connecticut, has elected to have the needed surveys and studies performed by private engineering firms under consultant arrangements.

It is apparently typical of these programs as now operated that the bulk of the work is of the "brushfire" variety--day-to-day handling of individual applications and inquiries, with relatively little attention devoted to planning or long-range surveys. However, some states have recognized the need for long-range programs and are planning for action.



## CITATIONS TO STATE FLOODWAY ENCROACHMENT AND DAM-SAFETY LAWS

1. Existing State Laws Regulating Encroachments and Obstructions on Stream Channels and Floodways.

Connecticut--25 Conn. Gen. Stat. 110 et seq.  
 Illinois--19 Ill. Ann. Stat. 70 et seq.  
 Indiana--27 Ind. Stat. Ann. 1117 et seq.  
 Iowa--25 Iowa Rev. Code Ann. 455A. 33 et seq.  
 Kentucky--KRS 104.400.  
 Maryland--66C Md. Code Ann. 721.  
 Massachusetts--3 Mass. L. Ann. C. 91, § 12A.  
 New Jersey--58 N.J. Rev. Stat. 1-26 et seq.  
 Pennsylvania--32 Pa. Stat. Ann. (Purdon) 681 et seq.  
 Washington--86 Wash. Rev. Code 16.010 et seq.  
 West Virginia--W.Va. Code § 5988.

2. Existing State Laws Regulation Safety of Dams through Licensing, Inspection, Etc.

Arizona--45 Ariz. Rev. Stat. 703 et seq.  
 California--Calif. Water Code §§ 6200, 6225, 6350, 6355, 6363.  
 Idaho--42 Idaho Code 1707-9.  
 Indiana--27 Ind. Stat. 1801 et seq.  
 Iowa--25 Iowa Code Ann. 469.1 et seq.  
 Kansas--82A Kans. Gen. Stat. 301 et seq.  
 Kentucky--KRS 104.400.  
 Maryland--66C Md. Code Ann. 721.  
 Massachusetts--3 Mass. L. Ann. C. 91, § 12A.  
 Montana--89 Mont. Rev. Code 701 et seq.  
 Nebraska--46 Neb. Rev. Stat. 257.  
 Nevada--Nev. Rev. Stat. 535.010 et seq.  
 New Hampshire--N.H. Rev. Stat. Ann. 482:3 et seq.  
 New Jersey--58 N.J. Stat. 4-1 et seq.  
 New Mexico--75 N.M. Stat. Ann. 2-8.  
 New York--N.Y. Conservation L. § 948.  
 North Dakota--61 N.D. Century Code 3-20.  
 Ohio--Ohio Rev. Code Ann. (Page) 1521.06.  
 Oregon--Oreg. Rev. Stat. 543.300, 541.510, 540.350 et seq.  
 Pennsylvania--32 Pa. Stat. Ann. (Purdon) 681 et seq.  
 Rhode Island--46 R.I. Gen. Laws 19-1 et seq.  
 South Dakota--61 S.D. Code (Supp.) 157.  
 Utah--73 Utah Code Ann. 5-5 et seq.  
 Vermont--10 Vt. Stat. Ann. 701 et seq.  
 Washington--86 Wash. Rev. Code 16.010.  
 West Virginia--W.Va. Code § 5988.  
 Wisconsin--31 Wisc. Stat. Ann. 01 et seq.  
 Wyoming--71 Wyo. Stat. 74.

## CHAPTER 7

### LEGAL ASPECTS

This chapter will touch briefly upon the legal aspects of flood damage abatement programs in North Carolina. No attempt is made here to supply a general summary of the law relevant to public programs in this area, nor of the law of private rights and liabilities arising out of flood damage. Rather, the effort is merely to present for consideration some current and potential legal problems.

#### Flood Plain Regulations

##### Validity

Any vigorously enforced flood plain regulations--whether embodied in zoning ordinances, subdivision controls, building regulation, or floodway encroachment lines--may be tested in the courts. The reason is obvious. All of these laws entail potential restrictions on the use of property which may prompt some landowners to question the validity of the restrictions.

The validity of flood plain land use regulations has been reviewed by several legal authorities.<sup>1</sup> These authors apparently agree that, assuming floods pose a sufficient social problem to justify public action, and assuming the necessary procedural guarantees are written into the statute, there is probably no basis for constitutional objection to flood plain regulations on principle. Such regulations should stand on essentially the same footing as other zoning or land use regulation, which have long been upheld by the courts. They are potential constitutional problems that should be taken into account in the process of preparing implementing legislation, notably in the area of equal protection, which counsel the need for careful drafting.<sup>2</sup> The battleground for any constitutional objections, however, is most likely to be the application of restrictions in the individual case. This emphasizes the necessity of careful and conscientious administration of flood plain regulations and provides another compelling reason for adequate funding of programs in this field.

### Enabling Legislation

Zoning--All cities and incorporated towns in North Carolina, and most counties, have long been empowered by general law to adopt zoning ordinances "for the purpose of promoting health, safety, morals or the general welfare of the community." This authority alone may be sufficient to sanction the inclusion of flood plain land use restrictions in zoning ordinances. The North Carolina Supreme Court has not passed upon the question, but courts elsewhere have sustained flood plain zoning ordinances which were apparently based on equally broad language.<sup>3</sup>

In 1957 the General Assembly adopted additional legislation authorizing counties and municipalities to zone areas subject to seasonal or periodic flooding. (GS 104B-2.) This law goes on to empower municipal and county governing bodies to designate a "zoning committee" to make zoning regulations, subject to the approval of the governing body. It also requires that copies of these regulations be forwarded to the State Insurance Commissioner, who is required on the request of the Federal Flood Insurance Administrator to advise whether such zoning regulations meet the requirements for flood insurance.

The 1957 enabling act was apparently intended to clarify local flood zoning powers and to establish eligibility of North Carolina citizens for Federal flood insurance. The latter purpose has not been achieved because the Federal flood insurance program was never activated. Unfortunately, it is doubtful that the purpose of clarifying local zoning powers was achieved either. The law as enacted has several shortcomings. First, it is possible that the law would be interpreted as being contingent upon activation of the Federal flood insurance program. Second, the provisions contemplating adoption of zoning regulations by a zoning commission are reminiscent of a law which was invalidated by the State Supreme Court in Harrington and Co. v. Renner, 236 N.C. 321 (1952). Third, contrasting this law with the general zoning enabling law, there are in this law some procedural gaps that might prove critical.

The peculiarities and possible defects of the 1957 legislation have caused confusion in the minds of some planning officials who are considering flood plain zoning measures. It is at least arguable that the authority of municipalities to adopt flood plain zoning ordinances would be "clarified" by the repeal of this law.

Other Regulations--So far as is known, the adequacy of existing subdivision control and building regulation laws as a tool for controlling flood plains land use has not been a subject of contention. Several points might be noted in this connection, however.

First, there might be some value in spelling out in the subdivision control enabling laws the power to require limited reservation of flood hazard areas for recreational or open space purposes. (For a related provision, see Section 5.42 of the 1961 Burlington City Charter--SL 1961, Ch. 119.)

Second, there might also be some value in spelling out in the subdivision control enabling laws explicit authority to restrict subdivision of building lots in flood hazard areas. (An illustration of such a provision is found in the Pennsylvania enabling law.<sup>4</sup>) The authority for making such restrictions in North Carolina now must be traced to rather general statutory language.<sup>5</sup>

Third, the Charlotte City Charter contains a provision empowering the city council to prohibit individual residential building construction in flood hazard areas that might have broader utility as a state-wide law. (Section 31 (16), Charlotte City Charter. Pub. Loc. L. 1939, Ch. 366 as amended by SL 1949, Ch. 560.)

Fourth, there are some cities and counties entirely exempted from the application of the zoning and subdivision control enabling laws. The repeal of these exemptions would, of course, be beneficial for flood damage prevention activities in the areas affected.

#### Protection of Outer Banks

Several efforts have been made by legislation to prevent further damage to the sand dunes on the Outer Banks. GS 104B, Art. 3, adopted in 1957, prohibits the damaging or destruction of the sand dunes or their vegetative cover without a permit from the appropriate city or county governing body. Another statute adopted in 1957, GS 68, Art. 4, prohibits allowing cattle and other listed livestock from running at large on the Banks, with certain exceptions. This act specifically empowers the State Department of Conservation and Development to remove or corral the Banks ponies from Ocracoke and Shackelford. Chapter 782 of the 1959 Session Laws directed the



sheriff of Carteret County to remove the livestock from the Carteret portion of the Banks by July 1, 1959. This last act was recently declared unconstitutional by the State Supreme Court, on the grounds that it was a local act relating to the abatement of a public nuisance in contravention of Article II, Section 29 of the State Constitution. Chadwick v. Salter, 254 N.C. 389 (1961).

While there is an established state policy of protection for the Outer Banks, it is apparent from this legislation that there is disagreement over the means of protection--particularly, whether local enforcement or state enforcement of protective regulations is more desirable. Perhaps a conference among the affected law enforcement officials and other interested parties would provide a good forum for further exploration of the question, if any is needed.

#### Small Watershed Enabling Law

The enabling laws for local organizations to carry out small watershed programs are described in chapter 5. These laws, being of recent origin, are going through a breaking-in period. Some amendments were adopted at the last legislative session to correct defects discovered during the first two years of operation under the enabling laws. A possible need for certain additional amendments is discussed hereafter (see pages 82 and 100).

#### Drainage Laws

Drainage district legislation has been on the books in North Carolina for over 50 years, and most of the rough spots in this legislation have been smoothed over. Indeed so many amendments have been adopted and in such ad hoc, haphazard fashion that the drainage legislation is now in need of general revisions and consolidation. While this is not a matter of any urgency, a recodification of the drainage laws would be desirable.

In addition, it should be noted that representatives of the State Highway Commission when contacted in connection with this study expressed a need arising out of their experience for updating and improving the drainage laws of the state. Presumably they are most interested in the case law and

legislation bearing upon the powers and liability of the state, especially in relation to highway construction.

### Local Legislation

North Carolina has a tradition of handling many of its legislative problems through adoption of local acts applying to a limited part of the State, commonly a single city or county. To this tradition the field of water resources is no exception. As a consequence, some of the legal problems in the field of flood damage prevention are concerned primarily or solely with local legislation. It is beyond the scope of this report to explore these problems. It is desirable, though, to point out that, as long as the local act tradition persists, some of the legal problems in this field can be resolved only within the framework of local legislation.



## PART II

### CASE STUDIES

A broad survey of the flood damage problems of an entire state, such as this one, of necessity must reduce to generalities the causes and consequences of flood damage. But floods are not generalities. They are natural disasters that produce personal tragedies. They kill, they injure, they blight human lives with financial ruin. They darken the economic prospects of communities and the state.

This part of the study seeks to bring the problem of floods closer to home in a series of case studies. The studies span Eastern, Piedmont and Western Carolina. (Specifically, they cover the Upper French Broad Basin, the coastal counties, and Crabtree Creek near Raleigh.) They illustrate a variety of causes, consequences and remedies. Hopefully, from them will emerge a more intimate understanding of flood problems, and a better basis for evaluating the effectiveness of various approaches to preventing flood damage.





## CHAPTER 8

### UPPER FRENCH BROAD BASIN: FLOOD DAMAGE PREVENTION, FLOOD CONTROL AND OVER-ALL RESOURCE DEVELOPMENT IN WESTERN CAROLINA

#### Flood Damage History and Potential

##### 1961 Floods

"Crops Hard Hit, Roads Flooded";<sup>1</sup> "WNC Assessing Flood Damage";<sup>2</sup> "Flood Victim's Body is Found."<sup>3</sup> Headlines such as these in late August 1961 editions of the Asheville Citizen hint at the heavy losses suffered from late summer floods in Western North Carolina.

Investigations by the Tennessee Valley Authority unhappily revealed that more than 1.25 million dollars of property damage was caused by the two-day floods in areas of the Upper French Broad Basin. Hendersonville was dealt the greatest damages which it has ever experienced due to floods; thirteen commercial establishments were flooded at Asheville; and residential properties suffered in both cities. Heaviest losses were suffered in rural areas--crop losses accounted for nearly 86% of the total damage figure.<sup>4</sup>

Truck crops were particularly hard struck. Hazy was the memory of repeated damages to truck crops in the repeated summer floods of 1949; and truck crop acreage on flood plain lands had increased since that summer to the extent that the 1961 floods, whose height equaled or "slightly exceeded" the 1949 flood height, damaged roughly twice the truck crop acreage as the 1949 flood.<sup>5</sup>

Past floods seem to be easily forgotten in urban areas as well as rural. At the intersection of U. S. 25 and 176 in Hendersonville, commercial development has constricted the floodway such that the 1961 flood height equaled the highest flood of record (July 1916) in that city.<sup>6</sup> The peak discharge of the 1961 flood, however, was roughly one-eighth of that in 1916.<sup>7</sup>

#### Regional Flood Damage Potential

This past summer's flood in the upper French Broad River Valley introduces into this report what it inevitably reestablished at Asheville, Hendersonville, and Brevard: an awareness of the flood damage potential of

Western North Carolina. In this section policies, programs, and attitudes affecting the flood damage potential are examined in a regional framework, specifically the French Broad River Valley, Western North Carolina. Further, they are viewed in the context of multiple-purpose water resources development.

Urban Damage--The proximity of the major population centers of the French Broad Valley to the Valley's principal rivers--the French Broad, the Swannanoa, and the Pigeon--gives a first indication of the regional flood damage potential. Such a pattern of development is quite natural when considered in the light of water supply, industrial location requirements, and scenic amenities. But the ominous fact remains that urban development is subject to flood damage when placed in the natural path of flood waters. And no matter whether a warehouse at Asheville or a manufacturing plant at Hendersonville or a residence at Marshall were placed near the river under a conscious awareness of the flood damage risk, the fact remains that in the event of flood damage, public funds are called upon for relief and prevention of further damage.

Rural Damage--Given a mountainous terrain, extremely fertile river valleys and limited use made of irrigation, a pattern of bottomland farming in the French Broad Valley is to be expected. Here again, when development is located near the river, it is subject to flood damage. In truck cropping areas more than one planting has been destroyed in a single season.<sup>8</sup>

History of Damages--Flood damages are on the increase in the French Broad Valley. Records show that since 1900, 41 floods in the region have caused damages reported to be in excess of \$5,000.<sup>9</sup> Of these 41 floods, 17 caused damages reported to be in excess of \$50,000; and 3 floods caused damages in excess of one-half million dollars. Significantly, of the total 41 floods under discussion, 29 have occurred since 1931. In other words, 75% of the floods were experienced in the latter half of the period.

Heaviest urban damages have been experienced along the main river. Since 1900, Asheville has reported flood damages in excess of \$1,000 a total of 11 times; Hot Springs 4 times; and Hendersonville 2 times.<sup>10</sup> In all, 10 cities in the region have reported some amount of flood damages at least once.

The agricultural flood damage potential is equally, perhaps more, serious. In the 1961 summer flood crop damage and other tangible losses by farmers totaled \$1,187,150. Total tangible non-farm damage from the storm

was \$67,650.<sup>11</sup> TVA estimated that crop damages of the same general order were also suffered in the last major floods, those of 1949. (In 1949 three separate crops were affected by flooding.)

### Land Use Planning and Regulation for Flood Damage Prevention

Flooding, which may indirectly affect each citizen of the Nation through Federal flood control project funds is often essentially a local problem with its most serious consequences at home. The TVA Local Flood Relations Branch has logically extended this proposition to mean that, likewise, urban flooding problems can best be dealt with by local and state governments. The gospel it preaches is to prevent flood damages before they start by keeping development away from hazardous areas--the support and control of this action being of a local nature.

Of course, in built-up areas such as the river front area in Asheville, the problem of keeping man away from the flood plain would certainly be enormous. The great investments in this industrial and commercial property are enough to forestall serious thoughts of relocation. Certainly in such an area, flood damages might better be abated by means of protective works and channel improvements. To this end TVA has proposed the construction of a levee at Asheville.<sup>12</sup> But where flood plain lands are yet undeveloped there is a good case for keeping them free from obstruction.

The importance of local public support for preventive programs is quite apparent. TVA (in its local flood relations program) and the U. S. Army Corps of Engineers (in its more recently initiated flood plains information studies) are well aware of this. In recognition of the necessity of local support, both TVA and the Corps have adopted policies which require local initiation of any study and, in North Carolina, close coordination of activities with the State Department of Water Resources.<sup>13</sup>

### Studies in the Upper French Broad Region

TVA has completed local flood damage reports covering eight communities in the French Broad Basin: Asheville, Black Mountain, Montreat, Canton, Clyde, Hendersonville, Hot Springs, and Marshall.<sup>14</sup> (See map on page 23.) A report is in process also for the Swannanoa area.

In the French Broad Basin few significant attempts at using the TVA flood plain studies have been made. Under the direction of the Western North Carolina Regional Planning Commission, a revision to the Hendersonville zoning ordinance was prepared late in 1959<sup>15</sup> to include a floodway district or flood plain zone. An ordinance revision was prepared setting the limits of the floodway of Mud Creek at the elevation of the Regional Flood. Improvements listed as permissible in the floodway district are farming, recreation, parking, and other open uses such as used car lots, storage of materials not subject to floating away, highways, and railroads. Such things as housing, commercial enterprises, and land fill other than that required for highway or railroad construction are not permitted.

At elevations slightly higher than those in the floodway, the "floodway fringe" uses are restricted to those permitted in the floodway district and in addition, such buildings as may be approved by the planning board. The primary requirement for approval is that floor elevations conform to expected flood heights.

The city of Hendersonville has not adopted its floodway zoning ordinance. Of the 98 communities throughout the Tennessee Valley which have received TVA local flood plain studies, 26 have adopted or proposed ordinances regulating land use with the aim of reducing flood damage.<sup>16</sup>

The preventive approach to flood damage reduction would normally be best suited to an undeveloped area where expensive development in the flood plain would not pre-empt the usefulness of flood plain restrictions. A case in point is the recent experience at Maggie, North Carolina, near the western edge of the French Broad Basin, a peaceful agricultural community which had experienced little economic eminence until the relocation of U. S. Route 19 through the valley in 1946.<sup>17</sup> Almost at once Maggie became a direct link from Asheville to some of the most frequently visited recreation areas of the Smoky Mountains. A locally organized group, the Maggie Valley Development Association, realized the economic potential of the highway and also realized that planned physical development of the community could greatly boost its economic status. Through close cooperation with TVA and the State of North Carolina, the Association was able to obtain the services of students of the Department of City and Regional Planning, UNC. In 1954 a development plan, complete with model, was presented by students to a citizens meeting at Maggie.



At that time no importance was given to the flooding danger of Jonathan Creek, a tributary of the Pigeon River which flows through Maggie.

In 1957, when the TVA local flood plain study, Floods on Jonathan Creek in Vicinity of Maggie, North Carolina, was presented it became apparent that rather severe floods could be expected from the stream, if only at long intervals. Students at Chapel Hill immediately began to revise the Maggie Valley development plans, adjusting land use patterns to conform to the new flood information. A floodway was outlined on the land use map where originally motels, commercial developments, and a community center had been proposed. At present, however, there are no legal tools for direct implementation of either the land use plan or the floodway district unless the area incorporates.

Hand in hand with zoning regulations in areas subject to flooding go regulations on the construction of new residences. Subdivision controls are being used in some areas of Tennessee and North Carolina to regulate the floor elevations and other pertinent features of new residential construction.<sup>18</sup> More prevalent in Western North Carolina are controls on the financing of new residences which insure compliance with the best known flood data for a particular area. Such agencies as the Federal Housing Administration, the Public Housing Administration, and the Veterans Administration have received copies of the TVA local flood plain studies. Each agency has a policy of not approving buildings known to be subject to flooding; and when doubt as to flooding risk arises, each agency will require sufficient information to clear that doubt. Eligibility of individual homes or subdivisions will be determined partly on the basis of flooding information such as that provided in Western North Carolina by the TVA reports.

### Proposals for River Control and Development

#### U. S. Army Corps of Engineers Navigation Improvements

Except during very brief periods, activities aimed at stream improvement in the French Broad Basin have been concerned with flood control. In 1877, when it was believed that navigation could be made profitable on the upper French Broad River, the Corps constructed a series of wing dams to improve the river channel.<sup>19</sup> Soon it was found that interest in navigation weakened and that the wing dams caused bank erosion. In a report dated

January 25, 1921, the District Engineer wrote that the problem created on the Upper French Broad should properly be treated as an aspect of a comprehensive approach to Valley-wide flood control.

#### TVA Proposals Following 1940 Flood

Organized public support for river improvement has been directed toward flood control rather than navigation since the unhappy experience of the 20's. In 1940, after extremely damaging floods, local interests formed the Western North Carolina Flood Control Committee to seek relief from flood damages. The Committee petitioned the Tennessee Valley Authority for aid, and TVA began at once to investigate the possibility of controlling floods in the French Broad Basin (one of the tributaries of the Tennessee River).<sup>20</sup>

Early in the process of investigation, TVA engineers realized that a major multiple-purpose structure in the French Broad Basin could not be justified under conditions then prevailing or predictable. It was learned also that no structure of a size that would affect Valley-wide flooding could be justified solely on the merits of flood control benefits. Faced with the economic unfeasibility of a major river improvement structure TVA turned to the tributary watersheds of the French Broad River as sites for smaller structures. In 1950 TVA submitted a report to the President of the United States in which a plan for controlling floods in the French Broad Valley was outlined. Including seven fixed-outlet detention basins near the mouths of upper tributary streams, channel enlargements in a portion of the French Broad River, and a levee at Asheville, the scheme was designed to significantly reduce both rural and urban flood damages on the main stem.

TVA's recommendations never found the solid local support needed to carry them against determined opposition. And inevitably they did arouse such opposition. This stemmed mainly from owners of rich bottomlands along the tributaries, which would have been overflowed periodically by the detention basins. TVA did not push its French Broad plans against the objections that had arisen.

#### Small Watersheds

Soon after the emergence of the TVA flood control recommendations, a series of small watershed proposals affecting much the same area were

developed. These involved Cane Creek in Henderson and Buncombe Counties; the upstream sources of the French Broad in Transylvania County and extending slightly into Henderson; Mills River in Henderson and Transylvania; and Mud Creek in Henderson. The proposals were initiated under authority of Public Law 566, as administered by the Soil Conservation Service. (See map on page 36.)

In typical small watershed fashion, the proposals contemplated a number of small flood retarding structures located mainly on the uppermost reaches of the small tributaries. Their main object was and is agricultural flood protection. An individual project might also directly benefit urban or industrial property--as in the case of protection promised by the Mud Creek project to property within the city of Hendersonville. And, in addition to flood protection, there is some possibility for municipal and industrial water supply benefits on a small scale, notably in the Upper French Broad project. In some instances there may also be public recreational possibilities. Notwithstanding these incidental features, though, the main justification and impetus for these proposals lay in their promise of agricultural flood protection for a rich, and potentially richer, farming area.

Local organization for these programs has made mixed progress. An initial drive was made to create watershed improvement districts for each tributary project, but this was dropped in favor of a move to organize county watershed programs in Henderson and Transylvania Counties. (The differences between watershed improvement districts and county watershed programs are discussed in chapter 5.) Elections were held by the two counties in the spring of 1961. In Transylvania the plan carried easily but in Henderson it failed by a sizeable margin. The Henderson defeat came as a surprise to optimistic watershed backers, and they were slow to recover lost momentum. It was again defeated in the Henderson election held in November 1962.

Supporting Federal programs, having properly followed the lead of their local counterparts, are now marking time in some respects and trying to make up for lost time in other respects. A watershed work plan was completed by SCS for Mud Creek; with the defeat of the Henderson County referendum, the work plan lies dormant awaiting further local action. By contrast, the rapidly developing Transylvania County local program outstripped its Federal support, being ripe for action well before completion of a work plan.

The Henderson County experience illustrates the organizational dilemma that confronts the local sponsors of PL 566 projects. Should they seek to organize a watershed improvement district, which is relatively easy to initiate but difficult and complex to operate and finance? Or should they seek to launch a county watershed program, which is risky to initiate (because of the legal requirement for approval by the voters of the entire county) but should be relatively easy to operate and finance? Since the root of this problem seems to lie with the benefit assessment feature of the districts and the county-wide vote feature of the county organization, a possible answer might lie in a combination of the two forms, permitting organization of tax financed programs on a watershed basis, which would require approval by only the voters of the watershed. While the existing small watershed enabling statute does not authorize such an arrangement, the General Assembly has granted this authority to one area by special act.

One further matter should be touched upon. TVA's authority under Section 26A of the TVA Act to regulate man-made obstructions affecting flood control in the Tennessee River and its tributaries has been previously described. As noted then, this provision standing by itself apparently gives TVA an effective review over flood control projects of other governmental agencies within the Tennessee Valley, including SCS small watershed proposals. (See page 30.)

Also pertinent in this connection are Executive Order 10,913, signed in 1961, a predecessor order dating from 1955 (10,614), and an agreement between SCS and TVA, all relating to the coordination of Public Law 566 projects with other Federal water resource developments. Executive Order 10,913, among other things, requires the Secretary of Agriculture to request TVA's views concerning the feasibility of achieving the objectives of any proposed PL 566 project in the Tennessee Valley by means of flood control works constructed under the TVA Act, and to authorize planning assistance for the project only after considering whether an alternative TVA project would be a more appropriate method of achieving such objectives. The TVA-SCS agreement, made in 1958, spells out in detail procedures to coordinate their mutual small watershed activities.

Work plans covering several watersheds have been submitted for TVA review, but TVA has replied that the work plans were not in sufficient detail



for Section 26A consideration. In turn TVA has given SCS its views on several proposed watersheds under the Executive Order, stressing the desirability of a regional approach to water control and water use in the area. As reflected in the following paragraphs TVA is now taking steps that lend substance to this suggestion.

#### TVA Tributary Area Development Program

To round out the picture, the impact of an additional element should be considered: TVA's new Tributary Area Development Program. The broad outlines of this program were described earlier (see page 39) and it was noted that the Upper French Broad Basin is one of the first areas to come under the new program.

To review, TVA has recently launched an effort to survey intensively all of the resources of this region. On the basis of the survey a comprehensive plan of regional resource development will be prepared. The plan may or may not recommend construction of reservoirs for flood control or other purposes on the French Broad or its tributaries; the locations of any such reservoirs may or may not coincide with those recommended in the 1950 TVA proposal; the small watershed structures now under consideration may or may not be found compatible with river control recommendations contained in the plan; the plan may or may not require new legislation for its implementation--all of these things now lie in the realm of speculation.

The Upper French Broad survey is being conducted through the joint efforts of the Department of Water Resources, the Western North Carolina Regional Planning Commission, North Carolina State College, and TVA. Prior to the survey phase a broad regional economic study was prepared under contract by planning consultant Philip Hammer and Company for the Regional Planning Commission.<sup>21</sup> The survey includes inventories of regional resources and economic activities. The inventories of forestry resources, human resources, and agriculture are well underway, as is a study of potential industrial sites. A tentative framework for projection of regional economic growth has been developed. Participants in the studies include affected TVA divisions; a team of economists from N. C. State College; the Department of Water Resources and the Western North Carolina Regional Planning Commission.



The Hammer Report, it may be noted, predicts an increasingly powerful economy for Western North Carolina, due in large measure to improving transportation facilities and flexible labor resources. A major point to be stressed is that the anticipated economic growth will be reflected, it is thought, in extensive expansion of urban areas, notably the Asheville area. Since the region's urban core areas are now situated in close proximity to rivers and streams, it is logical to expect that, unless preventive measures are taken in advance, flood plain encroachment would be sharply accelerated by further urban growth. The foundation for dealing with this problem is set forth in the existing and proposed TVA local flood plains studies. It is to be hoped that the affected communities will bestir themselves to take preventive action.

At this point it is appropriate to comment on the status and prospects of TVA's tributary area development project.

The exhaustive research and surveys underway can hardly fail to make a major contribution to future regional development. TVA's success in drawing upon diverse agencies and institutions for research is an encouraging sign. Encouraging too has been the participation of the Western North Carolina Regional Planning Commission and the State Department of Water Resources as coordinating elements.

However, there are two somewhat discouraging elements. First is the over-lapping jurisdictions of TVA and the SCS--two major Federal agencies having responsibilities in the area. In the background of any TVA-SCS relationship are differences in objectives and methods between the two agencies. SCS is developing water-control and watershed management plans for certain parts of the total basin. The comprehensive survey and planning process for the Upper French Broad Basin may result in delaying or changing of plans for some small watershed projects.

The second element is the natural intraregional rivalries of upstream vs. downstream interests; and the rivalry between urban and rural areas. Both interagency and intraregional differences will have a bearing on the ultimate development of the region. For optimum development of the region, they should be resolved.

There is, then, a real challenge to the people of the region and to local, state, and Federal levels of government to minimize these factors and lead the way to accelerated economic growth and development in the region.

## CHAPTER 9

### HURRICANES AND OTHER COASTAL STORMS AS A FLOOD PROBLEM IN EASTERN CAROLINA

#### Introduction<sup>1</sup>

Throughout the years hurricanes and other coastal storms have caused substantial damage to North Carolina coastal areas. Damages have tended to increase in recent years because of increased development of coastal areas--particularly urban development and tourist facilities.

The extent of storm damage varies with a number of physical factors--notably the area covered by destructive winds, the wind velocity, the height of storm tides, and the path of the storm. To illustrate the last of these factors: About one-half of the 67 hurricanes that have threatened the North Carolina coast since 1879 veered northeast of Cape Hatteras. These storms caused little direct damage, though often resulting in high tides, high winds, and fresh water flooding in coastal areas. Of course, the extent of damage also depends in large measure on the degree to which man has occupied storm-affected areas and the protective and preventive measures that have been taken.

#### 1954-55 Hurricanes

One of the most damaging hurricane seasons to affect the state occurred in a 13-month period during 1954-55, when four hurricanes--"Hazel," "Connie," "Diane," and "Ione"--hit the coast with terrific force disrupting the economy and threatening lives. To illustrate the potential of hurricane damage it is valuable at this point to review the damage that occurred during these storms. Estimates of damages were developed as a part of the "North Carolina Hurricane Project," a report by the Council of Civil Defense, and are of course only approximate. Their extent is however impressive. Total damages were estimated at \$318,993,000. When it is considered that the total state tax levy for the 1953-54 period was only \$302,000,000, the magnitude of these losses becomes apparent.

Damage to agriculture by the three storms in 1955 (the 1954 storm "Hazel" occurred after harvest) to farms in the 22 coastal counties alone totaled 55.5 million dollars, including 49.9 million in crops, 0.7 million in



HURRICANE DONNA DAMAGE ALONG CAUSEWAY NEAR MOREHEAD CITY

livestock and 4.9 million in farm buildings. In the larger area of the 42 coastal plain counties damage reached 141.4 million.

Forestry losses totaled \$900,000 for the three 1955 storms--"Connie," "Diane," and "Ione"--and in many areas flooding accounted for from 75 to 100 percent of these damages. The fishing industry being water based is particularly vulnerable to hurricane damage. Hurricane "Hazel" destroyed or damaged the capital equipment of the industry--boats, piers, fish houses, etc.--to the extent of \$1,500,000. This sum is equivalent to about 20 percent of the value of the total fish catch in a given year.

Cities and towns in North Carolina's coastal areas suffered substantially during the 1954-55 storms. Total damage in the state to private property, excluding agriculture, forestry, and fisheries was approximately \$109,000,000 and damage to public property about \$17,000,000. The most serious cause of urban damage was flooding. Streets and utilities were heavily hit and standing water which remained over much of the area for two weeks presented a definite health hazard.

No effort is made here to separate flooding damage from wind damage, salinity damage, and wave damage, a task beyond the scope of this report.

#### Damage Abatement Programs

##### U. S. Army Corps of Engineers Studies

Significant in the efforts to ease hurricane flood damage was the passage of Public Law 71, 84th Congress, which authorized the Corps to make, "an examination and survey of the eastern and southern seaboard of the United States, with respect to hurricanes, with particular reference to areas where severe damages have occurred." The purpose of these studies is to find the best means of preventing loss of life and damage to property.

Studies have been completed and projects authorized for the Carolina Beach, Wrightsville Beach, and Fort Macon areas. Other area studies are currently underway with the hope that the hurricane damage problems of all developed portions of the coast may be analyzed as time and resources permit.

Carolina Beach Report--The Carolina Beach Report illustrates the comprehensive approach taken on these studies. The principal cause of



hurricane damage in this area is the constant and rapid erosion of beach and dune areas. Accordingly, the hurricane study discussed above was combined with a Beach Erosion Control Study previously authorized for the area.

The study area comprises approximately seven miles of the North Carolina ocean shore in New Hanover County along the peninsula which separates the lower Cape Fear River from the Atlantic Ocean. It extends from the northern edge of the town of Carolina Beach to the southern extremity of the town of Kure Beach. Permanent population in the area is low, but a holiday weekend may see as many as 50,000 people visiting the beach. Businesses associated with serving these tourists, and commercial fishing activities, make up the dominant portion of the economy.

The area was severely hit by the 1954-55 hurricanes, with Carolina Beach experiencing a twenty percent decline in assessed valuation as a result of hurricane "Hazel."

The report of the Corps states that there are three factors which are directly related to the amount of damage caused at any particular location:

- (1) Natural causes
  - (a) abnormal tidal heights and wave action
  - (b) wind effects on structures
  - (c) excessive rainfall
- (2) Operational causes
  - (a) inadequate forecasting
  - (b) inadequate distribution of forecast information
  - (c) inadequate emergency plans
  - (d) inadequate administration or execution of emergency plans
- (3) Causes related to improper design or location of structures
  - (a) inadequate building standards and codes
  - (b) inadequate zoning regulations

Early in 1955 a dune ridge was constructed along the shore from Carolina Beach Inlet to Fort Fisher, with funds provided by the Federal Civil Defense Administration. In order to restore the dunes, sand fences were constructed along the crest.

A rubble concrete groin was completed at Carolina Beach in June of 1955 but was destroyed during the 1955 hurricanes. Construction of twelve low, short groins, which was initiated by local interests and financed jointly by public and private sources, has recently been completed.

In order to provide a sound base for evaluation of alternative solutions a stage-damage curve was developed for the study area. With records of known maximum tidal flood stage heights from previous hurricanes, resulting damage from each, and probable frequencies, a stage damage curve was derived. Average annual physical property damages were then computed.

The plan recommended for the protection of the entire study area consists of a 50-foot-wide berm or ridge constructed to an elevation of 12 feet above mean low water, topped on its landward side by a dune with a top elevation 15 feet above mean low water. While improvement under this plan would not provide complete protection against hurricane flooding, it should prevent the greater part of water damage.

Average annual benefits from the Carolina Beach project are estimated at \$376,000. Total costs for the project would equal \$1,289,000, with annual costs, including amortization and interest, estimated at \$123,110. At the time the Corps report was prepared the Federal share of total costs was \$739,000, or approximately 60 percent, leaving a non-Federal share of \$500,000. A development subsequent to the Corps report has changed the picture. Section 103 of the Rivers and Harbors Act of 1962 substantially increased the maximum allowable Federal contribution to shore protection projects of this sort. If the Carolina Beach cost-sharing arrangements are revised under the new law, this may result in a material decrease in the requirement for non-Federal contributions. Nonetheless, the non-Federal cost may still be beyond the means of the affected communities, and some measure of state (as well as local) participation may well be necessary.

#### North Carolina Hurricane Project

The "North Carolina Hurricane Project," a report completed following the 1954-55 hurricane study, made a series of recommendations for development of a damage prevention program.

The study expressed the view that the best combination of local participation and responsibility, financial resources, and adequate area for

the comprehensive planning and execution of hurricane protective measures was probably some type of special district. Functions to be assigned to the district would include:

- Planning and construction of drainage projects
- Plans for diking to guide individuals
- Water storage projects
- Beach erosion control and sand dune preservation
- Land use appropriate for subject areas
- Coordinate activities of various units

Localities were to take part by developing hurricane provisions in zoning and building codes, develop a comprehensive planning program with the hurricane problem as a significant consideration--this could be effectuated at the state level through administration of the Federal 701 Local Planning Assistance Program by the Division of Community Planning--and the construction of minor public works.

The study proposed that the state adopt a policy of construction of hurricane damage prevention facilities and grants-in-aid to localities for approved projects. In addition a revolving fund for low interest loans was suggested, as well as state guarantee of local bond issues. A program of comprehensive damage insurance was recommended, either through private companies or if this were impossible then through the state itself.

Action on Recommendations--The study recommendation for special hurricane districts has not been implemented, nor the recommendations for creation of a state revolving loan fund and state guarantee of local bond issues. As previously noted, the state has made some appropriations for construction of facilities and to meet local cost shares on Federally-aided projects.

#### Dune Building Project on the Outer Banks

The North Carolina General Assembly in 1959 appropriated \$600,000 to the Department of Water Resources for shore protection and preservation of the Outer Banks (SL 1959, Ch. 1039). Two hundred thousand dollars of this money was later allotted to an experimental study of the effects of dune

building on the Outer Banks. In October 1959 the project was begun, in cooperation with the Army Beach Erosion Board.<sup>2</sup> With the use of state prison labor an experimental 10-mile section of sand fence was constructed on Portsmouth Island, to explore the utility of sand fencing as a device for building up dunes to provide better protection against beach erosion. This work enabled comparison of the relative cost and effectiveness of different kinds and arrangements of fencing.

An interim report on the study is in preparation. On the basis of what has been already learned the Beach Erosion Board has asked the state to support the project for at least one more year. At its quarterly meeting in January 1962 the Board of Water Resources granted this request.

The results of this study will be awaited with interest. If they indicate that dunes can be built effectively and economically by sand fencing, then it might be within the means of the affected localities, perhaps with some help from the state, to largely solve the problem of beach erosion. If not, continued reliance on the more traditional means of erosion control and beach rehabilitation--such as the measures recommended in the Corps report on Carolina Beach--will probably be required. And in turn, this will probably mean continued reliance on capital outlays by the Federal Government.

#### National Park Service Program

Substantial expenditures have been made for hurricane protective works in Dare County by the National Park Service, within the Cape Hatteras National Seashore Recreational Area. The Park Service program includes extensive land acquisition and stabilization by grass planting.

#### Dare County Program

A program of local action has been developed by Dare County. To coordinate activities during periods of hurricane danger a "Hurricane Preparedness Plan," was developed by the County Civil Defense Advisory Committee.

The County Civil Defense Director is given full and sole authority to issue advisories and warnings, with radio, television, and newspapers requested to limit distribution of hurricane information to official releases. In addition, the plan sets up procedures for alerting all emergency



communications and law enforcement facilities, for coordinating the activities of all other affected agencies in case of an emergency, and for designating and making available proper shelter areas in each section of the county. A two-way radio network combining public and private facilities will link all portions of the county with the control center.

In addition the Storm Rehabilitation Committee prepared a handbook explaining to the individual property owner what he can do to protect his beach front. The booklet describes sand fencing, construction and maintenance of dunes. This report has stimulated a widespread program of stabilization by grass planting in various parts of the county by private citizens.

#### Local Building Codes

One promising local practice which is receiving increasing recognition is the adoption of building code regulations that require storm resistant construction. Such regulations, modeled after a code originated in Dade County (Florida), are now in force in Carolina Beach, Wrightsville Beach, Nags Head, and Dare County. The staff of the State Building Code Council has given advice and assistance to some coastal communities on these regulations.

#### Summary

(1) When it is realized that hurricanes, which may strike any part of the North Carolina coast, can cause damages within a 13-month period greater than the total state tax revenue, then it becomes clear that every effort must be made to develop an effective program of damage prevention. Not only are the initial damages great, but destruction of natural resources and capital equipment paralyzes the coastal economy.

(2) In broad terms the elements of a program of hurricane damage prevention appear to include adequate storm warning and disaster relief systems, physical measures to control shore erosion and to rehabilitate damaged beaches, and land use regulations designed to minimize damages.

(3) No serious questions have been raised concerning existing warning and disaster relief measures. Federal and state programs apparently

operate to general satisfaction. At the local level a program such as Dare County's shows what can be done locally.

(4) In the wake of recent destructive storms research is still in process to identify the most effective and economical physical means of controlling shore erosion and rehabilitating damaged beaches. Its results will bear upon financing questions as well as upon a choice of physical methods.

(5) It is apparent that the task of restoring and maintaining shore protective works is beyond the capacity of local governments in the area. Continued Federal aid will undoubtedly be essential. A basic issue to be settled is the proper role of the state government in this area.

(6) Another element of a comprehensive damage prevention program lies in the application of building codes and other regulations relating to land use.

The state has moved directly in one aspect of land use regulation by enactment of legislation prohibiting unjustified damage to sand dunes along the Outer Banks. Presently the application and enforcement of this law is left to local governments.



## CHAPTER 10

### CRABTREE CREEK: A PIEDMONT SMALL WATERSHED PROJECT IN A MIXED URBAN-RURAL SETTING

#### Introduction

This case study describes a small watershed project that has been initiated on Crabtree Creek. Several reasons prompted the selection of this area for a case study:

The first watershed improvement district in the state was organized here.

The project portrays a wide range of approaches for preventing flood damage in a mixed urban-rural setting--flood retarding structures, channel improvements, regulatory measures, and public land acquisition.

It typifies some of the organizational problems that have confronted small watershed programs in North Carolina.

It illustrates well the potentialities for cooperation of city and county governments in small watershed programs.

It also illustrates some common interrelationships between small watershed programs and other water resource developments.

#### Flood History

Crabtree Creek rises in southern Durham County and flows easterly some 20 miles, through northern Raleigh, into the Neuse River. The Crabtree headwaters are in a farming area and are commonly flooded at least once a year, with resultant crop losses and depressed land values. Its greatest flood damage potential though, is in the downstream urban section in and around Raleigh. (This obviously indicates a need for something other than a strictly agricultural flood damage abatement program, a point to which we will recur later.) A twelve-year frequency storm in 1957 caused estimated urban damages of more than \$100,000, as well as a nearly 100 percent crop loss. Equal flood stages had occurred in several prior years, but losses were lighter because the flooded areas were comparatively undeveloped.





RALEIGH FARMER'S MARKET FLOODED BY CRABTREE CREEK

The 1957 flood affected 50 homes, the Raleigh Farmer's Market and other industrial developments. A recurrence of this storm today would damage an estimated 150 homes. The Raleigh area has been growing rapidly since 1940 and an early end to this trend seems unlikely.<sup>1</sup> The prospect in this growing area is for increasing exposure to flood damage risk within the urban portion of the watershed.

### Proposed Small Watershed Program

To meet these flooding problems a small watershed program has been initiated and a local small watershed organization, Crabtree Creek Watershed Improvement District, was formed in 1960. This organization was the first of its kind in the state. Before the district was created, SCS had made a preliminary study of soil and water conservation needs indicating that a project was feasible, and an application for planning assistance was approved by SCS and granted a priority by the State Soil and Water Conservation Committee.

### City and County Participation

It has already been indicated that the most serious flood damage losses along Crabtree Creek occur within the city of Raleigh. And 90% of the benefits from the proposed plan of protection have been assigned to this urban property. But the Watershed Improvement District Law does not permit this same urban property to be included within the district or assessed for benefits. The questions raised are obvious: Is it feasible or fair to organize a small watershed program, under such circumstances, without financial contributions from those most benefited? Is there any indirect way to obtain payments from or on behalf of these beneficiaries?

The answer in Crabtree Creek has been an assumption of financial responsibility by the City of Raleigh and Wake County. Initially the city and county made payments of \$3,000 each to the newly formed district and indicated their willingness to repeat such payments annually. (This contribution, if continued, would approximately match estimated annual maintenance costs.)

This promised help, however, shortly proved insufficient. When watershed district trustees began seeking easements for land that would be

overflowed by proposed impoundments and for land bordering the creek within the city of Raleigh that would be subject to overflow, they discovered that a number of landowners were unwilling to donate the easements. In some areas, property ripe for subdivision is involved, and values might exceed \$1,000 per acre. The trustees soon realized that they were confronting previously unanticipated land acquisition costs running into many thousands of dollars. (The root of their problem is probably the philosophy of the national soil conservation movement, which has assumed that landowners would readily donate easements in return for the benefits of Federal aid. This has proven an unrealistic assumption in urbanizing areas where land has subdivision value.)

The trustees were unwilling to consider raising the needed money through an assessment, because the landowners of the district had been told by project backers that no assessments would ever be levied against them. To prevent the project from falling through, the trustees and SCS turned again to the city and county for help, seeking an assurance of funds to buy easements. Once again the city and county governing boards responded favorably. In concrete terms, they authorized the watershed trustees to apply the \$6,000 previously appropriated for maintenance purposes toward hiring personnel to attempt to buy easements from reluctant landowners. The City Council also reacted favorably to a suggestion that, if necessary, it might restrictively zone a strip along the creek within the city limits so as to control building within the flood plains. What further specific aid will be given, only the future can tell. However, a policy of support for the project has been established and, so far, the Council and the Board of Commissioners have implemented this policy whenever the need for implementation has arisen.

Elsewhere in the state the problem of meeting unanticipated preliminary expenses has been very troublesome. Although watershed improvement districts are empowered by law to borrow funds the authorizing legislation requires some amendments to make it workable. Even curing these defects may not be the answer, however, because indications are that the best source of loan funds (Farmers Home Administration) will not advance funds until an assessment roll has been completed--often too late to meet the financial needs of the districts.



### The Plan for Protection

The plan being developed by the sponsors with SCS assistance for protection of Crabtree Creek watershed contemplates, first, construction of 16 or 17 small dams on tributary streams which will restrict peak volumes and potential damage. In addition, the main channel will be widened, deepened, and straightened to accommodate a substantially larger flow. In one area the channel may be lined with concrete, the sharp bend at Farmer's Market.

The project as proposed will provide protection within the main channel for a 100-year flood, in accord with current SCS policy on projects affecting urban areas where human life might be endangered by floods. No more than 50-year protection is required by SCS on watersheds where flooding does not significantly threaten loss of life.

### Other Water Resource Developments

Mention should be made of a related water resource development being considered by the Research Triangle Planning Commission. The Commission's staff has made studies indicating a need for substantial augmentation of stream flows in the three-county Triangle Region (Durham, Orange, and Wake Counties) in order to keep pace with projected water supply and sewage disposal demands of a growing populace.<sup>2</sup> Four potential reservoir sites have been identified, including one on Crabtree Creek and one on the Neuse itself, the latter being a site recommended by the U. S. Army Corps of Engineers for inclusion in its plans for over-all development of the Neuse Basin. (The planning study thus far has focused only on physical aspects of the problem--identification of sites, estimates of reservoir capacity, etc. The question of what unit or units of government might undertake to construct and maintain the facilities has not yet been confronted.) The Crabtree Dam would back up into Umstead State Park a three-billion gallon reservoir, designed for flow augmentation and recreation. This dam would probably make unnecessary one or more of the structures under consideration for the small watershed project. For this reason the Planning Commission consulted with the watershed sponsors and also with Corps personnel. There appears to be no conflict of objectives in either case. The Corps' plans for development of the Neuse River do not include any reservoir above Falls of the Neuse. In any event present Corps

authority and program objectives would not embrace construction of reservoirs of the kind or size envisioned by the Planning Commission.

When the Planning Commission proposals became known, naturalists pointed out that the Crabtree impoundment would inundate a virgin wilderness area of unusual biological interest in Umstead Park. After considerable discussion a compromise has apparently been reached which will provide for inclusion of a dam without a permanent pool in the small watershed plan that will not adversely affect the wilderness areas of the Park.<sup>3</sup>

Two points are worth making. First, the Planning Commission is serving an important regional interest here which is met by neither the Corps nor the small watershed program. The really critical water resource development needs of this region in the years to come are likely to be those identified by the Planning Commission. No available Federal program would have supplied these needs. Second, the timing of the Triangle study is significant. The Planning Commission Staff was able to move into action before the small watershed or Corps program had proceeded so far as to freeze a pattern of development that would stand in the way of other, perhaps more relevant, measures. At this early stage free discussion was possible and helped the parties to recognize the complementary nature of their respective programs. As it happened other interests intervened in this case and may have changed the ultimate results, but this does not detract from the point made here.

#### Land Use and Regulation

In evaluating flood protection to a particular area it is essential that existing and potential use of the land to be protected be carefully considered.

Existing land use data for the Crabtree Creek flood plain is available from the Raleigh City Planning Commission and the Research Triangle Planning Commission. Discussions with the Raleigh City Planning Department indicate that relatively little development has taken place in the urban portion of this flood plain. This has resulted because of general knowledge of the flood threat, and discouragement of development through subdivision review. In addition the Planning Department has attempted with some success to persuade developers to either dedicate to the city portions of their land lying in the



flood plain or to reserve it for park purposes on the subdivision plat. However, projections of growth potential made by the Research Triangle Planning Commission suggest that demand for land along many portions of the stream will increase in the near future. With this thought in mind and recalling the extent of damages--over \$100,000 in 1957--which occurred when development of the flood plain was relatively limited, the value of protection is evident.

In the course of their preliminary investigations of Crabtree Creek Watershed, SCS personnel concluded that completion of the watershed projects was likely to foster subdivision of land and other development within the flood plains. They foresaw that within a few years this might create new flood damage potentials possibly even exceeding the flood protection benefits of the project. It was this realization which prompted the request, previously mentioned, for restrictive zoning of the flood plain by the city of Raleigh. Subsequently, modifications have been proposed in channel improvement features of the project which may prove to be an adequate substitute for flood plain zoning. Be that as it may, this remains a good illustration of the merits of a comprehensive approach to flood damage prevention, which combines physical protection with land use regulation and public land acquisition in the vulnerable flood plains. If general recognition of this principle spreads, the day may indeed come when the trend of mounting flood losses will actually be reversed.



## CHAPTER 11

### CASE STUDIES: SUMMARY

(1) Three case study chapters are included in the report, covering a variety of flooding problems and flood damage abatement programs in representative parts of the state. The study areas are:

One river basin that is an area of major flood damage potential, the Upper French Broad Basin. This chapter illustrates the interplay of preventive and corrective measures with over-all water resource development. It also reflects some of the problems encountered in coordinating various agency activities.

The flooding problems of the coastal region arising from hurricanes and other ocean storms. This chapter reviews North Carolina's hurricane history and efforts to reduce the resulting damage.

A Piedmont small watershed project in a mixed urban-rural setting, Crabtree Creek (a Neuse River tributary in Wake and Durham Counties). Some typical organizational problems of small watershed projects are illustrated here, along with the possibilities for coordinating these projects with preventive measures.

(2) The case studies illustrate both the opportunities for effective local flood damage prevention programs afforded by the TVA and Corps flood plain studies, and the progress that can be made by local planning departments without the help of such studies. As appears from the French Broad case study, TVA flood plain studies are now or soon will be available for a substantial segment of the flood-prone communities of western North Carolina. When the related Corps program gets well underway similar studies will be available in the Piedmont and East.

(3) The French Broad case study points to the need for more vigorous local regulation of the use of flood plains. In Western Carolina, where TVA reports have been prepared for twelve communities, only one flood plain zoning ordinance has so far been proposed.

(4) As reflected in the Crabtree study, the Federal flood control agencies have adopted policies designed to stimulate greater preventive efforts. Thus, SCS seeks to encourage local action such as flood plain regulations and land acquisition which will complement and strengthen the small watershed plan of protection. And, as was seen in an earlier chapter (see page 35), the Corps has gone a step further by actually requiring the local interests to agree to prevent encroachments that would adversely affect project operations.

(5) Coastal problems: Repeated and extensive coastal damage from ocean storms have become familiar headline news in recent years. A great deal has been done to reduce the toll of damages from future storms, but nonetheless much remains to be done.

In the way of preventive action, substantial amounts of ocean frontage have been acquired by both Federal and state governments on the Outer Banks to serve as a buffer zone or for recreational use. Further acquisitions are being considered. Also, several coastal towns and Dare County have adopted building regulations requiring storm resistant construction, but action by other affected communities is needed. Also needed are land use controls that will halt indiscriminate cutting of protective dunes, protect vegetative cover on barrier dunes, and prohibit construction in areas especially prone to storm damage. It is encouraging that most of these measures are under active consideration in some coastal communities.<sup>1</sup>

A large measure of corrective action is also required for significant reduction of coastal damage. Steps now underway include experimental planting of vegetative cover for dunes by the National Park Service in the Hatteras National Seashore; experiments on the use of sand fencing as a means of building protective dunes, by the Park Service in Hatteras and by the State of North Carolina in cooperation with the Army Beach Erosion Board on Portsmouth Island; and hurricane damage surveys by the Corps. The Corps has completed surveys covering Wrightsville and Carolina Beaches, whose key recommendations entail construction of substantial berms topped by protective dunes. Despite generous Federal financial assistance the local cost share in each case may be beyond the financial capacity of the communities in question. Because of this the possibility of state participation may be considered. There is some precedent for such action, a 1959 appropriation of \$150,000 to help pay the "local" share of shore protection and beach erosion prevention projects.



(6) Small Watershed Programs: The Crabtree Creek case study illustrates the point that good cooperation from city and county governments is essential to the success of small watershed projects located in mixed urban-rural areas. Because urban property cannot be assessed for benefits from small watershed projects, some financial contribution from the city or county in lieu of the assessment may be necessary. In addition, the inclusion of preventive features in the project will necessarily hinge upon city or county cooperation, since small watershed organizations lack the authority to regulate land use and lack the wherewithal to undertake substantial flood plains land acquisition programs.

In Crabtree Creek Watershed the city of Raleigh and Wake County have been most cooperative. They have indicated a willingness to pay the anticipated project maintenance costs and have helped defray easement acquisition costs. In addition Raleigh has reacted favorably to a suggestion that a strip of creekside land be restrictively zoned, if necessary, in order to control building within the flood plains.

Two typical organizational problems of small watershed programs are illustrated in the Crabtree and French Broad studies.

First, preliminary expenses of these programs, notably for easement acquisition, are proving much larger than was anticipated. Especially in urbanizing areas where land has subdivision value, fewer landowners have been willing to donate easements than had been hoped. Unanticipated preliminary expenses are particularly troublesome because no reliable method of financing these expenses has yet been devised.

Second, another organizational problem arises in the selection of the form of local watershed organization. The North Carolina enabling law permits a choice between two forms: a watershed improvement district and a county watershed program. The former is financed by an assessment on benefited property within the district; the latter, by a county-wide ad valorem tax. (Organization of a drainage district may offer a third alternative in some cases. Drainage districts are financed by assessments.) The organizational choice may be a hard one because each alternative has distinct advantages and disadvantages.



## PART III

### CONCLUSION

#### CHAPTER 12

### ELEMENTS OF A COMPREHENSIVE POLICY FOR REDUCTION OF FLOOD DAMAGE POTENTIAL IN NORTH CAROLINA

#### Introduction

This report has sought to portray the flood damage problem in North Carolina. First, it surveyed the nature and scope of the problem, the known methods of abating flood damages, and the existing flood damage abatement programs of Federal, state, and local governments. Then, by means of a series of case studies, it proceeded to examine more closely some typical flood damage problems in Coastal, Piedmont, and Western Carolina.

Against this background we are brought to a consideration of future flood damage abatement programs and policies for North Carolina, with particular emphasis on the preventive approach. The issue may be stated broadly, in terms of the title to this chapter, as follows: What are the elements of a comprehensive policy for reduction of flood damage potential in North Carolina? More specifically we will be seeking to identify the preventive measures that might be undertaken by the State Government and to place them in a context of a comprehensive flood damage abatement program.

It may be helpful to begin by briefly highlighting the findings of the report to this point.

(1) Periodic flooding is an inevitable natural phenomenon. Flood damage, however, is not the natural result of floods but the result of developments in flood plains.

Flood damage is not peculiar to any one part of North Carolina, but is a problem of statewide dimensions. Especially vulnerable are coastal settlements, developed urban flood plains, and bottomland farms.

(2) Historically, the alleviation of flood damage has been sought mainly by protective measures, such as dam building and channel improvement. In the last quarter century alone, over \$4 billion for the nation has been spent by the Federal Government for this purpose. Despite these heavy

expenditures for flood protection, the toll of flood damage continues to rise. The principal cause is becoming increasingly clear: The relentless encroachment upon flood plains by land development.

(3) A growing public awareness of these facts has led to a search for other ways to abate flood damage, a search that has produced a variety of new methods aimed at preventing damage rather than controlling floods. Prominent among these new methods are land use controls applying to flood plain areas (such as zoning and subdivision controls), and public land acquisition.

(4) All levels of government have something to contribute to programs of flood damage prevention: local governments, through land use planning and regulation appropriate to local areas; the Federal Government, primarily through programs of planning assistance; and state governments, through planning for state facilities, land use planning and regulation appropriate for regional areas, and coordination of Federal and local activities. Flood hazard areas may be acquired at any level of government.

(5) There follows a brief review of the actual flood damage prevention activities carried on today in North Carolina by local, Federal, and state governments.

Local governments: About a half dozen counties and cities in the state have taken some positive action to regulate flood plain development, by zoning provisions, building regulations, or subdivision control policies. At least as many more have considered or are now considering similar action. A number of municipalities have acquired land in flood hazard areas by dedication, gift, or purchase and devoted the land to parks and other open uses--thereby effectively minimizing the flood damage potential of these areas. North Carolina has a strong local planning movement, as witnessed by some 175 city, county, and regional planning boards existing in the state today. With this solid core of local planning agencies it should be possible to formulate flood damage prevention programs in most localities where these programs are needed.

Federal agencies: The major Federal contribution lies in the local flood plains studies conducted by TVA and the Corps, which compile the information needed for effective local flood damage prevention programs. TVA has completed such studies covering a dozen Western North Carolina communities and has several more under consideration or in process. The Corps has



received applications for about two dozen similar studies in the Eastern and Piedmont sections, though none of its studies is yet complete. Other Federal preventive activities include Weather Bureau river and tidal flood forecasting, regulation of channel obstructions within the Tennessee River Valley segment of North Carolina, public land acquisition (as in the case of the Cape Hatteras National Seashore Recreational Area), and dam-safety inspections undertaken by several Federal agencies. Also, in connection with its flood control proposals, the Corps is insisting upon adequate local regulation of flood plains to complement the flood control projects.

State government: Several agencies of the state government currently have some interests in this field. The Department of Water Resources coordinates local applications for TVA and Corps flood plains studies; advises school and highway authorities on flood problems; and has limited responsibilities relating to the safety of PL 566 dams. The Division of Community Planning, in carrying out its program of local planning assistance, from time to time advises cities and counties of needs and opportunities for regulating land use in flood hazard areas. Similar contributions are occasionally made by the Recreation Commission and the Building Code Council, in their fields of public recreation and building regulation.

(6) Some other states have undertaken more extensive programs. Almost a dozen states have laws regulating encroachments on channels or floodways; over two dozen have laws providing for licensing or inspection of dams in the interest of public safety. The State of Hawaii has given the state government an unusual role in the zoning process, and Tennessee has considered a legislative proposal to enable the state to adopt zoning regulations applicable within flood hazard areas currently unserved by any local planning agency.

(7) The small watershed program, which is concerned mainly with agricultural flood damage, employs a combination of preventive and protective measures. These programs are initiated and maintained by local organizations (either special districts or counties), and coordinated by the State Soil and Water Conservation Committee. The Federal Government acting through the U. S. Soil Conservation Service, finances planning and capital costs.

(8) In a brief review of current legal issues two possible problem areas were emphasized. One involves flood plain zoning, where there is some

confusion in the enabling legislation for city and county zoning. The other involves the small watershed enabling laws, where provisions concerning borrowing authority and form of local organization may need revision.

### Conclusion

With the limited resources available for the purpose, the State Government of North Carolina has in recent years taken the first steps toward developing a flood damage prevention program. The remainder of this report will attempt to lay the foundation for a broader state program of flood damage prevention.

### Elements of a State Flood Damage Prevention Program

The preventive approach to flood damage abatement, as has been seen, comprehends various techniques of land use regulation and related measures, such as open space preservation, tax adjustments, public land acquisition, warning signs and flood insurance. We will consider now some ways in which state government in North Carolina might play a more active role in flood damage prevention than it now plays.

One obvious way in which the State of North Carolina could move to implement the preventive approach is to adopt legislation providing for regulation of encroachments on channels or floodways. Such laws are now on the books in 11 states. As was pointed out in chapter 6 some encroachment line statutes empower an administrative agency to determine the location of the line beyond which encroachments may not be placed. Other statutes attempt to fix the location of the line more or less precisely. The statutes, as they have been applied, vary from those that merely prohibit obstructions within the channel to those that take as their bench mark some historic flood and reach back from the banks to prohibit obstructions within the historically hard hit portion of the flood plain.

A related move would involve enactment of legislation requiring the checking of dams and levees for safe design and construction. As was noted earlier, 20-odd states have laws of this sort. North Carolina has no general legislation or program on this subject, but several state and Federal agencies do concern themselves with some aspects of the problem. (For details see pages 31, 47, 65, and 66.)

Public acquisition of land or easements to prevent undesired obstruction or settlement of flood-prone areas offers another way of achieving the objective sought by encroachment line legislation. Existing public acquisition programs are carried on largely by Federal agencies and local governments. But there is nothing to prevent the State if it wishes from more actively engaging in a similar program, and there have been some precedents for this in North Carolina and elsewhere (see pages 49 and 67).

Systematic acquisition of potential sites for flood control or multiple-purpose dams and reservoirs might be undertaken along with or independent of public acquisition of flood-prone areas. During a period of rapid urban and industrial growth it is almost inevitable that some of the best potential damsites will be pre-empted for other uses. Or, what may amount to the same thing, land values may skyrocket and virtually price damsites out of the market for public acquisition.

Potentially beneficial to many activities, including flood damage abatement, would be an acceleration of topographic mapping programs for North Carolina. Basic topographic mapping is not available for large areas of the State. This work could be stepped up by increased State matching contributions to the U. S. Geological Survey.

There are other possible elements of a comprehensive state program of flood damage abatement, including flood insurance, erection of warning signs and tax adjustments. The feasibility of a state-sponsored insurance plan is doubtful if only because of the magnitude of the financial risk involved. There are better prospects that the obstacles which have stood in the way of a Federal flood insurance plan will be surmounted. As to warning signs, the State is in no position to move in this direction until it has accumulated far more data concerning flooding than is now at its disposal. Tax adjustments for flood losses would help lighten the burden of those who suffer financial loss from floods. The form of tax adjustment might be so designed as to encourage types of land use that would reduce flood damage potential. However, special tax treatment is contrary to North Carolina's traditions, and it would probably require a very strong showing of both need and demand to persuade the General Assembly to allow tax adjustments for flood losses.

### Coordination of State Government Programs

Along with or independent of these preventive measures might appropriately go an effort to bring about a closer coordination of State Government programs affected by flood damage problems. The State agencies that might profit from such an effort would certainly include at a minimum the Departments of Water Resources and Public Instruction, the Highway Commission, the Recreation Commission, the Division of Community Planning, and the Soil and Water Conservation Committee. The various Federal water agencies might be brought into the picture either from the start or after coordination of state activities had been established.

Some good working ties already exist but there is room for improvement to provide even better program coordination. There is no established mechanism for general interchange of information among all of the affected organizations.

The values of good coordination in this area are often quite tangible and substantial. Within the recent past the contact between the Departments of Water Resources and Public Instruction permitted identification of a serious flood damage risk in a proposed Madison County school expansion. A study by the Department of Water Resources resulted in modifications of location and construction that significantly reduced the flood damage risk. Upstream on the same river (the French Broad) a proposed major highway location was recently spotted by TVA officials in time to recommend a change of location that would prevent a serious conflict with a potential flood control damsite.

### Data Collection and Analysis

A fundamental element in any program concerned with the flood damage problem is the collection and analysis of data concerning floods and flood damage. Without adequate information no effort to control floods or to reduce flood damage can succeed.

Collection and analysis of flood data for all purposes, it has been pointed out, is now performed almost exclusively by Federal agencies. The State of North Carolina has nevertheless made some substantial contributions to these activities in recent years--for small watershed planning, beach erosion studies, and surface and ground water studies. By thus stimulating and assisting Federal and local programs, the State plays much the same role here as in flood control and flood damage prevention activities.



What shall be the pattern of the future in this field? Among the patterns that might develop are the following:

(1) The State might seek to supplant or duplicate the work of the Federal agencies in this field. (Merely to state this proposition suggests the answer: It is a rather unlikely prospect that few would seriously advocate.)

(2) The State may wish to continue its present role of relying on Federal agencies for collection and analysis of flood data, and contributing state funds from time to time to support Federal and local programs of unusual promise.

(3) Whether or not it continues to support such Federal and local programs, the State may wish to develop an independent staff that can devote some attention to the collection and analysis of flood data, without in any sense supplanting or duplicating the work of the Federal agencies.

Two possible avenues for such a development are suggested by existing activities of the Department of Water Resources.

The stream sanitation program offers an example of the assembling of a staff of experts to administer a regulatory law and the collection and analysis of basic data as an incident of this work. Undoubtedly a similar result might be achieved with regard to flood damage data by means of the adoption and implementation of regulatory laws to reduce flood damages--e.g., a floodway encroachment law and a dam-safety law.

The collection and analysis of data by a staff whose primary function is to answer inquiries and make surveys is illustrated by the Department's current ground water program. Should the State of North Carolina fail to adopt regulatory measures for flood damage prevention, the pattern illustrated by the Division of Ground Water might be applied in the field of flood damage, and in this fashion a state program of flood data collection and analysis might be developed.

#### Flood Control Projects

To fill out the picture we will touch briefly on the subject of flood control.

Flood control measures of all sizes, shapes and forms, are today constructed or financed almost exclusively by Federal agencies. The State and its subdivisions help pay for incidental expenses on some projects (such as right-of-way acquisition, planning, and maintenance on small watershed projects) and even for a share of construction costs in the case of beach erosion and shore protection projects. By and large, though, actual construction is financed entirely by the United States.

As would be anticipated, the Federal agencies make most of the important decisions in this area concerning such matters as program content, program levels, project timing, and site selection. But, with increasing frequency, state agencies are being called upon to advocate or support specific proposed flood control projects. More often than not they are being called upon to take sides in Federal interagency disputes, choosing between competing proposals. The small staffs of the state agencies are hard pressed to analyze and evaluate the Federal proposals. They bring to the task no pre-existing blueprint or plan, and often no body of data against which to measure the Federal proposals other than information supplied by the sponsoring Federal agencies.

All of this goes to suggest an obvious incidental benefit of developing a positive state flood damage prevention program. The concomitants of such a program--increased staff, better developed plans, and enlarged information--would vastly improve the state's ability to intelligently evaluate and correlate Federal flood control proposals. This should bring about enhanced recognition of state and regional interests in flood control and multiple-purpose projects.

The case for active state participation at the planning stage of water resource programs has been well stated in a recent report to the Governor of Maryland:

Federal assistance is highly desirable and undoubtedly will continue to be beneficial to the State in the future. However, the State is likely to get the most for its money, and the best out of Federal assistance if it has its own mature plans for a future program and an organization capable of carrying it out. The ideal would be to have the State program so skillfully conceived that Federal assistance must necessarily

follow a pattern set by the State. In general this has not been true in the past. The most beneficial program for the State is not necessarily what Federal Government agencies propose to the State as both desirable and possible.<sup>1</sup>

These are the apparent avenues for state action--regulation of floodway encroachment, dam-safety regulation, increased participation in the collection and analysis of flood data (whether directly or as an incident of a regulatory program), public acquisition of flood-prone areas, strengthened coordination of state programs, accelerated topographic mapping, and public acquisition of potential damsites for flood control and related purposes. In addition there are the possible legal changes discussed earlier. At this point some critical questions naturally arise: Which, if any, of these measures should be undertaken? What are their pros and cons? What would they cost and what benefits could be anticipated from them? How might they best be combined? How should they be scheduled? What agency or agencies should participate in their administration? Could comparable results be achieved with lesser measures?

These issues will be explored in the ensuing sections on "Some Alternative Approaches and Combinations," "Program Administration," and "Benefits and Costs of the Program."

#### Some Alternative Approaches and Combinations

For convenience in discussion, the approaches and combinations discussed here will be labeled "alternatives." However, they are not all, strictly speaking, mutually exclusive alternatives.

Alternative 1--In order to move as rapidly as possible toward a goal of maximum flood damage abatement, all of these measures might be undertaken immediately on a state-wide basis. Several obvious questions come to mind: First, could this be accomplished efficiently, or would it not be necessary to break the work down into several phases? (And if, as a practical matter, the work must be scheduled or "phased" for effective operation, is it wise to create an impression of undertaking to move ahead simultaneously on all fronts?) Second, could a sufficient number of competent personnel be obtained to carry out the program on this basis? Third, could this be accomplished at a cost which the State is willing and able to bear? Obviously,

to move from a level of relatively little activity into a crash program on all fronts would entail large immediate expenditures.

Alternative 2--A decision might be made that all of these measures are desirable in principle, but that--because of personnel problems, or for reasons of economy or efficiency--it is not feasible to undertake them all at once. To this end, some form of phasing the initiation of the programs might be devised.

One method would be to initiate the various measures at different times. For example, the enforcement of a floodway encroachment law might be undertaken in year A. As soon as this was well under way, or no later than year B, the enforcement of a dam-safety program could be launched; and public acquisition programs could be initiated in year C. Efforts to strengthen coordination of affected state programs could probably be initiated at any time. (The dam-safety measure might need special handling, if it involved both licensing of new dams and inspection of existing dams. The inspection element could conveniently be phased either on a delayed effective date basis or on a regional basis. It might be thought desirable, however, to begin licensing new dams immediately on a state-wide basis.)

Another form of phasing is exemplified by North Carolina's stream sanitation law, which has been gradually placed in effect, river basin by river basin, during a period of about ten years. A similar approach might appropriately be applied with respect to the flood damage abatement measures under consideration here, using drainage basins or some other form of regional breakdown. The planning studies for a region could probably be tailored to produce information that would be relevant to the application of each of these flood damage abatement measures.

Alternative 3--The decision might be made to adopt one or more of the suggested measures and reject others. Given this decision, the desirability of phasing the initiation of those measures which were adopted could be considered.

Alternative 4--There might be agreement on the objectives of all of these measures but disagreement as to the means of achieving the objectives. Thus, some less costly or less stringent or more easily administered approach might be sought as an alternative.



A few examples will illustrate the possibilities--

It may be felt that the objectives of a dam-safety law could be substantially achieved at less cost and with less objections through development of safety standards for various kinds of dams; an educational-safety campaign based on these standards; and occasional spot checks of individual dams by state personnel. Or, it may be argued that a regulatory safety law should at least be preceded by an educational campaign of this sort for several years.

Regulation of floodway encroachment might be attempted on an experimental basis in selected areas of the State in order to obtain additional information concerning its operation and cost.

The potential cost of a public land acquisition program might be considered beyond the current means of state government. Yet it might still be thought worthwhile to compile information concerning land acquisition needs--perhaps at little additional expense in conjunction with the planning phase of a floodway encroachment program. This information could then be transmitted to the appropriate Federal and local agencies for their consideration. Furthermore, it might be useful to other state agencies in selecting sites for public improvements (such as the Highway Commission, in locating future highways).

#### Program Administration

Finally, the question must be faced: What agency or agencies should administer any program that is adopted?

It is appropriate to list some of the factors to be taken into account in considering this question. These include:

First, in the Act creating the State Department of Water Resources, the General Assembly moved to consolidate the major water resources agencies

of State Government in a single department. It would be consistent with the policy expressed in this Act to lodge major responsibility for flood damage abatement programs in the Department of Water Resources.

Second, at the same time it should be recognized that the program under consideration is made up of measures highly dependent on the tools of land use planning and regulation. State responsibility for land use planning and regulation lies mainly in the Department of Conservation and Development, and particularly its Division of Community Planning. This Division would hardly be the ideal agency to have primary administrative responsibility for the program, since virtually all of its work lies in the field of consultant services for local planning. However, the experience of its staff should surely be utilized in every possible way to help plan and establish the flood damage abatement program, and for consultation after the program is established. In some matters, it might even be desirable to require consultation with the Division.

Third, there are other state agencies which should be contacted or consulted on some matters. This category certainly includes departments involved in public construction programs which are subject to a risk of flood damage or which contribute to the flood damage problem, such as the Department of Public Instruction and the State Highway Commission. Maintaining close liaison between these agencies, the Department of Water Resources and other affected state offices is certainly in order.

Fourth, the best of cooperation among all affected agencies may fail to surmount one obstacle inherent in the existing structure of North Carolina State Government--the absence of a single agency with over-all planning responsibility. Such an agency could, for example, evaluate the over-all effects of a proposed floodway encroachment line far better than could any of the existing departments whose interests are involved. In the absence of an over-all planning agency, the best solution may be to entrust the performance of such functions to a specific employee or division of an existing department, in consultation with interested local and regional planning agencies.

Some kind of periodic, fairly frequent consultation among all of the affected agencies should be useful--perhaps in the form of an interdepartmental committee. As indicated earlier, the agencies that might profit by such an interchange include at least the Departments of Water Resources and Public

Instruction, the Highway Commission, the Recreation Commission, the Division of Community Planning, the Building Code Council, and the Soil and Water Conservation Committee. Interested Federal agencies might also be invited to participate.

### Costs and Benefits of the Program

There remains one issue on which further comment is indicated: The potential costs and benefits of the program.

Costs--A specific dollar and cents tag cannot be placed on the program at this stage, because there are so many variables in the picture. The scope of the program, the level of activity, the scheduling element--these and other features must be defined before a meaningful cost estimate can be made. However, some generalizations can be offered which may be helpful.

First, a few comparisons will indicate the cost range of an active state flood damage abatement program. The figures used reflect state appropriations alone, not accounting for Federal aid or other non-appropriated funds.

In a report prepared for the Ohio Water Commission in 1960, recommending a broad-gauged state program of flood damage abatement, a suggested budget was included for the recommended state organization.<sup>2</sup> Estimated cost in round figures was \$215,000 for the first year and \$360,000 for subsequent years, subject to increases in the cost of living. The budget provided for a professional staff of seven engineers, three engineer-technicians and three engineering aides.

The Ohio plan can be compared with a three-part program in actual operation in Connecticut, involving dam-safety regulation, establishment of floodway encroachment lines, and flood studies. Connecticut has chosen to conduct the surveys and studies required for these activities by contract with private engineering firms. The budget is running in the neighborhood of \$90,000 per year.<sup>3</sup>

The States of Iowa and Indiana also have adopted floodway encroachment laws which are administered by state personnel. In addition to issuing permits under these laws, their agencies engage in other related work such as conducting flood damage studies for municipalities on request (Iowa), conducting studies of subdivision flooding potential for FHA and VA (Indiana),

and performing flood control planning. Iowa's program is administered by the Natural Resources Council, whose present staff consists of a director, six engineers, two engineering aides, and secretaries. The Director of the Council estimates that one-third to one-half of its \$170,000 budget should be assigned to flood damage prevention activities. Indiana's program is administered by the Flood Control and Water Resources Commission and the staff work is performed by a Permit Section, with occasional help from other divisions. The Chief Engineer of the Commission estimates that approximately \$35,000 to \$40,000 of its budget is expended in operating its flood damage prevention activities.

A North Carolina activity of comparable, if somewhat larger, scope is the stream sanitation program. During the first full year of operation, fiscal year 1952-53, it employed an average of 13 persons and had a state appropriation of \$76,560. In fiscal year 1961-62 it employed an average of 43 persons and has a state appropriation of \$196,194. (This figure does not include \$136,688 in matching funds for cooperative hydrological studies with the U. S. Geological Survey.)

A substantial state flood damage abatement program could perhaps be initiated and maintained in North Carolina for a smaller expenditure than indicated by the preceding illustrations. These comparisons at least suggest, however, that the average annual outlay would probably at least be in the neighborhood of \$50,000 and might considerably exceed that amount. And it should be kept in mind that the comparative illustrations do not allow for land acquisition to preserve open space or protect flood control sites, nor for accelerated topographic mapping.

Second, a more modest level of activity could undoubtedly be undertaken at lesser cost. Two or three engineers (or planners with engineering training) could probably make reasonable progress on a program including such elements as: (a) an educational dam-safety campaign, (b) analysis of Federal flood control proposals from the point of view of state interest, (c) closer liaison among the various affected state agencies, and (d) experimental projects to test out the operation and cost of floodway encroachment regulation. This might be accomplished with an annual budget of considerably less than \$50,000.

Benefits--Having considered the potential cost of the program, we turn to an examination of its benefits. Again, we make no pretense of attaching a precise dollar and cents tag.



What are the areas of benefit?

First, there is the potential reduction of the mounting toll of flood losses--damage from major floods in North Carolina during the first half of 1962 alone exceeded \$25 million. Part of the loss, of course, is either practically unavoidable or can be curtailed only by corrective measures. But a significant portion is traceable to unwise flood plains development which can be controlled by a vigorous program of flood damage prevention.

Second, there is a potential saving in public outlays for flood control and disaster relief, which could be made unnecessary by preventive programs. No meaningful estimate can be made here of the amount of public expenditures that might be saved, but the savings nonetheless are quite tangible when they occur.

Third, there is a potential saving in public outlays involved in a systematic program of dam-site acquisition for future flood control and multiple-purpose projects. More significant than the possible savings in cost of acquisition may be the value of preserving for public use irreplaceable damsites.

Fourth, there are other significant positive effects not measurable in monetary terms.

Thus, there is the protection afforded to those persons whose lives, health, safety, and well-being might be endangered, but for these preventive measures. Land use regulations and public acquisition of flood plains may offer such protection to the potential home buyer who is unable to assess accurately the risk of flooding. Similarly, dam-safety regulation may protect the property owner menaced by an unsafe upstream impoundment.

Floodway encroachment regulations may prevent encroachments from so obstructing the floodway as to cause or increase flood damage to other property owners, damage which often would go uncompensated.

Fifth, a comprehensive flood damage prevention program would of course have advantages beyond its own immediate sphere.

As was previously suggested, the increased staff and improved planning and expanded knowledge that would result from such a program would improve the ability of State Government to intelligently evaluate and correlate Federal

flood control proposals. In this way, quoting from the Maryland State Planning Department, "the State is likely to get the most for its money, and the best out of federal assistance."<sup>4</sup>

Accelerated topographic mapping of the state would be of value in many other fields as well as flood damage prevention. Almost every form of public and private construction activity would be benefited.

Public acquisition of flood plains land for recreational use would of course serve the purposes of public recreation while helping to curtail flood damage potential.

Sixth, it was noted earlier in this report that the most recent river basin flood control proposal of the U. S. Army Corps of Engineers stipulates that local interests or the state--preferably the latter--must agree to provide adequate protection against downstream channel encroachment before the project is installed. This stems from a general policy which is likely to be applied on all such projects in the future. Thus, a state floodway encroachment law would help to make possible the development and control of North Carolina's major river basins.

General--Before concluding this section concerning benefits and costs, a word should be said concerning an element of "cost" not previously mentioned. We refer to the social cost inherent in any regulatory function, in this case the restriction upon the use of property resulting from floodway encroachment laws, dam-safety laws, flood plain zoning, etc. The legislatures of a number of states have apparently been satisfied that the sacrifice entailed by these restrictions is justified by the beneficial results of a program of flood damage prevention. Presumably the General Assembly of North Carolina will want to weigh this "cost" in the balance along with cost of public expenditures to finance the program.

#### Recommendations

The Board of Water Resources will review the data and conclusions contained in this report. Recommendations for conceiving and effectuating a statewide comprehensive program of flood damage prevention will be considered for presentation to the Governor and the General Assembly.

## FOOTNOTES

### Chapter 1

1. 86th Congress, Second Session - Committee Print No. 15, Floods and Flood Control (1960) p. 1.

2. Count taken from flood records data sheets prepared in connection with this study. Where one stream overflowed twice during the month both were counted--likewise with damages.

3. A. M. Lunetta, "Flood Plain Aspects of River Planning," Journal of the Hydraulics Division, Proceedings American Society of Civil Engineers 82 (1956), pp. 1040-1.

4. E.g., U. S. Senate Select Committee on National Water Resources, Floods and Flood Control, 86th Congress, 2nd Session, Committee Print No. 15 (1960), pp. 4-7. White and others, Changes in Urban Occupance of Flood Plains in the United States, Research Paper No. 57, Department of Geography, University of Chicago (1958), pp. 4-11, 203-208. Roland C. Holmes, Composition and Size of Flood Losses, from Gilbert F. White (Editor), Papers on Flood Problems, Research Paper No. 70, Department of Geography, University of Chicago (1961), pp. 11-15.

5. Statistics taken from flood damage data compiled in connection with this study. Damage figures not adjusted for price levels.

6. Ibid.

7. W. G. Hoyt and W. B. Langbein, Floods, 1955, p. 90.

8. U. S. Army Engineer District, Wilmington, Comprehensive Report on Cape Fear River Basin, North Carolina, (1961), vol. 1, p. 31.

9. Parsons, Brinckerhoff, Hall & Macdonald, Engineers, Report on Floods and Flood Damages, p. 3.

10. U. S. Geological Survey, Floods in North Carolina, Magnitude and Frequency, (1955) p. 6; (1961) p. 9. The 1955 report was authored by H. C. Riggs; the 1961 report, by William E. Forrest and Paul R. Speer.

11. Ibid., p. 1.

12. Charlotte Observer, August 14, 1916, p. 1; August 15, 1916, p. 2. Commissioners of Pickens County et al. v. Jennings, 181 N.C. 393 (1921).

13. Information derived from report to State Department of Water Resources on inspection for dam safety by James Turner (1962).

## Chapter 2

1. Task Force on Flood Plain Regulations, Committee on Flood Control of Hydraulics Division, American Society of Civil Engineers: A Guide for the Development of Flood Plain Regulations (1962), pp. 2-4.
2. D. A. Saunders, "Ordeal of an Industrial Valley," Fortune, 52(1955), p. 127.
3. James E. Goddard, Changing Concepts in Flood Plain Management, (address before Missouri Basin Research & Development Council, Bozeman, Montana, September 1960, p. 3).
4. White and others, Changes in Urban Occupance of Flood Plains in the United States, p. 235.
5. James E. Goddard, Flood Plain Regulations to Avoid Flood Damage (address before American Society of Civil Engineers, Reno, Nevada, June 1960, p. 3).

## Chapter 3

1. James E. Goddard, Flood Plain Regulations to Avoid Flood Damage, (address before Reno Convention of the American Society of Civil Engineers, June 22, 1960), pp. 9-10.
2. Tennessee Valley Authority, A Program for Reducing the National Flood Damage Potential (report submitted to and printed by Senate Committee on Public Works, 86th Congress, 1st Session, 1959), p. 9.
3. Task Force on Flood Plain Regulations, Committee on Flood Control, Hydraulics Division, American Society of Civil Engineers, January 1962.
4. Public Law, 87-330, 87th Congress, 1st Session (1961).
5. Corps of Engineers Manual: Water Resource Policies and Authorities, Flood Plain Information Studies (December 1961, 15 pages and appendices), EM 1165-2-111.
6. For example: Soil Conservation Service, Special Storm Report, Storm of June 4-5, 1957, Muddy Creek Watershed, Tributary of the Catawba River, North Carolina, (Raleigh, 1957, 10 pages).
7. TVA, Floods of August 1940 in Tennessee River Basin (Knoxville, 1940, 337 pages).
8. 33 United States Code, sec. 403.
9. 42 United States Code, sec. 2401, et seq.



10. 7 United States Code, sec. 1501, et seq.
11. Winston-Salem Journal, June 15, 1962, p. 1.
12. Source of information on Federal Power Commission procedures: correspondence with FPC Chairman Joseph C. Swidler.
13. Source of information on Soil Conservation Service procedures: report by James Turner to the Department of Water Resources on inspection for dam safety.
14. The Bureau of Reclamation of the United States Department of Interior builds flood projects, but its operations have been limited historically to the 17 western-most states.
15. Corps of Engineers Engineering Manual 1120-2-101, paragraph 1-84 q.
16. Letter to M. S. Heath, Jr., from E. G. Long, Jr., Assistant Chief, Engineering Division, U. S. Army Engineering District, Wilmington, 8 January 1962.
17. TVA Flood Control (Revised 1960), pp. 3-4.

#### Chapter 4

1. N. C. General Statute, ch. 143, sec. 355.
2. N. C. General Statute, ch. 143, sec. 341(6).
3. N. C. General Statute, ch. 113, sec. 15.1(b)(1).
4. Source: correspondence with State Civil Defense Director.
5. N. C. Session Laws 1961, ch. 833, Budget of North Carolina 1961-63, vol. 2, p. 602.
6. N. C. Session Laws 1959, ch. 1241.
7. N. C. Session Laws 1959, ch. 1039.
8. Ibid.
9. U. S. Army Engineer District, Wilmington, Combined Hurricane Survey-Interim Report Carolina Beach and Vicinity, North Carolina, 1961, p. 54.

## Chapter 5

1. The remainder of this section is based on correspondence with the Greensboro and Charlotte-Mecklenburg Planning Directors.

2. N. C. Session Laws 1961, ch. 233.

## Chapter 6

1. University of Chicago Press, Chicago, 204 pp. The study was made possible by a research grant from the Secretary of the Army and centered at the University of Chicago under the guidance of Gilbert White.

2. Murphy, op. cit. supra, note 1, pp. 34-35.

3. Murphy, op. cit. supra, note 1, p. 144.

4. The information in the following three paragraphs is derived from a report to the Department of Water Resources on inspection for dam safety by James Turner.

5. The discussion in this section and the following two is based upon a master's thesis in city planning at Georgia Tech, written by Henry F. Morse in 1962: The Role of the States in Guiding and Controlling Land Use in Flood Plains, pp. 22-25, 30.

6. Harold V. Miller, Flood Damage Prevention for Tennessee, Tennessee State Planning Commission, Nashville, (1960), pp. 68, 71-78.

7. Hawaii Acts, 1961, No. 187.

8. Hawaii Rev. L. 121-5.

9. Assembly Bill No. 617, N. J., 1961 Session.

10. Murphy, op. cit. supra, note 1, pp. 119-122.

## Chapter 7

1. See e.g., Dunham "Flood Control via the Police Power," University of Pennsylvania Law Review, vol. 107, p. 1098 (June 1959); Wertheimer, Flood Plain Zoning, California State Planning Board, Sacramento (1942) pp. 26-42; see Cooter, "To Stay out of Floods," National Civic Review, vol. L., No. 10, pp. 534-539 (November 1961).

2. See Dunham, op. cit. supra, note 1, 107 University of Pennsylvania Law Review 1098, 1128-1129, 1132.

3. American Land Co. v. City of Keene, 41 F2d 484 (1st Cir. 1930); McCarthy v. City of Manhattan Beach, 264 P2d 932 (California 1953), cert. den., 348 U. S. 817 (1954).

4. 53 Pa. Statutes Annotated 46676(b).

5. N.C. General Statutes 153-266.3, 160-226.3.

#### Chapter 8

1. The Asheville Citizen, August 25, 1961, p. 1.

2. The Asheville Citizen, August 26, 1961, p. 1.

3. The Asheville Citizen, September 4, 1961.

4. TVA, Flood of August 24-25, 1961, Upper French Broad River Basin, p. 17.

5. Ibid., p. 1.

6. Ibid., p. 2.

7. Ibid., p. 7.

8. TVA, A Flood Control Plan for the French Broad Valley (Knoxville, 1950, p. 3).

9. These and the following damage figures come from the flood damage data gathered for this study. Damages are unadjusted to current price levels.

10. This statement is the result of analysis of flood damage records assembled for this study.

11. TVA, Flood of August 24-25, 1961, Upper French Broad River Basin, p. 17. To these tangible losses TVA adds a 10-percent allowance for intangible losses.

12. See TVA, A Flood Control Plan for the French Broad River Valley (Knoxville, 1950).

13. The TVA and Corps of Engineers programs were described generally in chapter 3.

14. Other completed reports for Western North Carolina localities include Bryson City, Cherokee, Maggie, and Murphy.

15. See Proposals for Adjusting to Flood Conditions at Hendersonville, North Carolina prepared by the Western North Carolina Regional Planning Commission, November 1959.

16. These numbers are correct as of August 1962.
17. See Maggie Valley Plans, Department of City and Regional Planning, University of North Carolina, Chapel Hill, January 1955.
18. E.g., Subdivision Regulations, Athens, Tennessee, November 1956.
19. State of North Carolina, Board of Conservation and Development, Water Resources of North Carolina, French Broad River Basin, Raleigh, 1957, pp. 97-104.
20. For further information see: TVA, A Flood Control Plan for the French Broad Valley, Knoxville, 1950.
21. Hammer and Company, Associates, The Economy of Western North Carolina, Atlanta, 1961, 224 pp. and appendices.

## Chapter 9

1. The introductory section of this chapter relies heavily on a report by the North Carolina Council of Civil Defense, "North Carolina Hurricane Project," (published in 1955 following the 1954-1955 hurricanes), and on studies recently completed by the Corps of Engineers for Wrightsville Beach and Carolina Beach.
2. The Beach Erosion Board is an agency of the U. S. Army Corps of Engineers, which conducts studies and submits recommendations for solving beach erosion problems.

## Chapter 10

1. Research Triangle Regional Planning Commission, Research Triangle Region Population Estimates, 1970-1980 (1961), pp. 6, 14, 25-31.
2. Research Triangle Regional Planning Commission, Research Triangle Region General Plan for Development (1962).
3. Raleigh News and Observer, July 10, 1962, back page.

## Chapter 11

1. See Manteo Coastland Times, April 12, 1962; Elizabeth City Advance, May 10, 1962.



Chapter 12

1. Maryland State Planning Department, Future Administration of State of Maryland Water Resources Activities, Baltimore, 1961, p. 20.

2. Miles M. Dawson, "Flood Control and Flood Plains Regulation" (Columbus, Ohio 1960), pp. 62-67.

3. Figures derived from correspondence with William S. Wise, Director, Connecticut Water Resources Commission.

4. See footnote 1 above.



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Note: This is not a comprehensive bibliography but rather a selection intended to give a representative sample of publications in the field.

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